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THE

Popular Science Review.

A QUARTERLY MISCELLANY OF ENTERTAINING & INSTRUCTIVE ARTICLES ON SCIENTIFIC SUBJECTS.

EDITED BY JAMES SAMUELSON.

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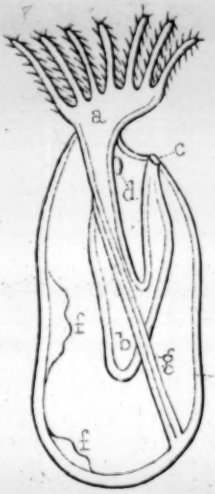

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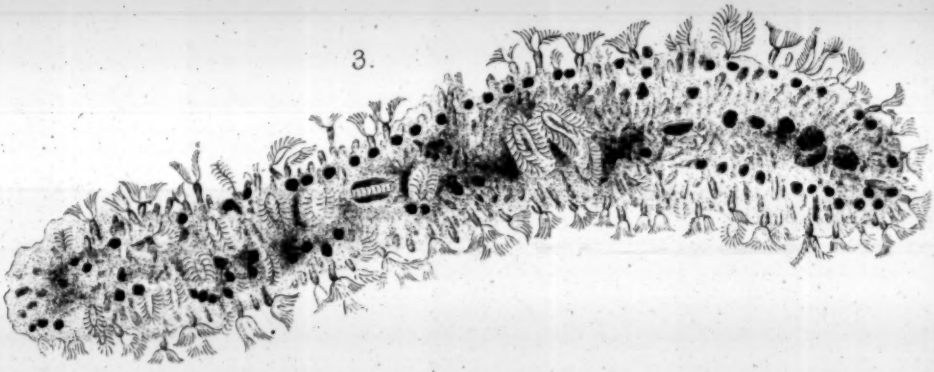

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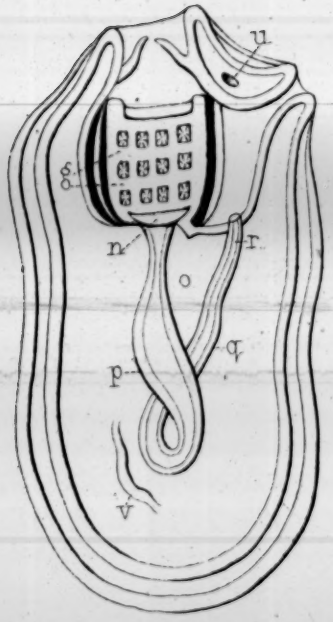

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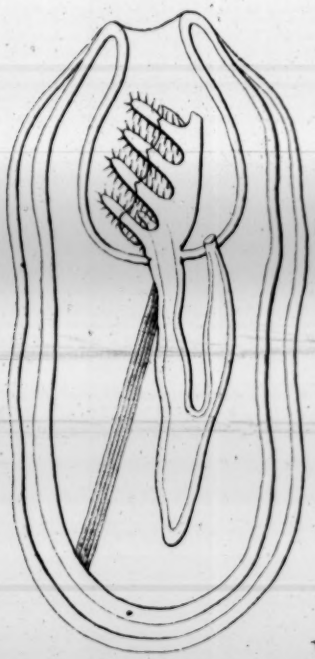

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Fresh Water Polyzoa.

W. West, Lith

1866, April 27.
Gift of Wm. James,
of Boston.

OUR FRESH-WATER POLYZOA.

BY THE REV. W. HOUGHTON, M.A., F.L.S.

OF all the beautiful forms of animal life that tenant the waters of our rivers and ponds in marvellous profusion, there are none, I think, that excel, and few that equal in elegance and interest, the Polyzoa. It is invidious, perhaps, to draw comparisons in nature, where all is perfect; the naturalist will see as much to admire in the common earthworm as in the rarest and most prized zoological treasure, not that in external form the humble worm recommends itself as an object of attraction, but because its structure, like that of every created thing, is so admirably adapted to the wants and habits of the animal. Be this, however, as it may, there is no doubt that beauty of external form, although it may be the only point for which the uninitiated care, is an additional charm in the eyes of the zoologist. Who does not remember the thrill of pleasure that ran through him when first he beheld, through the magic crystals of the microscope, a group of *Vorticellæ* with their delicate spiral stems and ciliated glassy bells? or who that has ever watched the beaded *Melicerta* mould its tiny round bricks, and then bend itself down and add pellet after pellet to its tube, will say he has not experienced a more than ordinary treat, and a kind of gratification which it is impossible to describe?

This is the month of April, and it is too early to attempt to find specimens of any of the species of Polyzoa, with the exception of *Fredericella Sultana*, of which more anon. Still, take your collecting bottles and pocket lens, and come along with me: I shall be able, I know, to teach you a useful lesson in the art of discovering Fresh-water Polyzoa; for you must know that it is quite possible you may be living close to a pond in which live hundreds of one of the most prized species, and yet be quite unable to find a single specimen. We will go to this large reservoir, which supplies the canal; here the water is beautifully clear, and in the summer time the willows and alders on the margins of the bank form a pleasant shade, and ever and anon let fall their dead branches into the water, a

favourite object of attachment to all this group; here grow, but not too closely together, several aquatic plants,— water crowfoot, amphibious Persicaria, the copper-coloured Potamogeton (*P. perfoliatus*) with transparent leaves like goldbeater's skin, and other plants of the water.

Now let us go to some sheltered spot or corner of this great pool, to which the wind has blown all the floating rubbish, tangled masses of Confervæ, decayed roots of grasses, feathers of birds, etc., and dip our bottles into this heterogeneous mass. Never mind the ironical smile of yonder angler, who, proud of the pike of twelve pounds weight which he has just succeeded in landing about twenty yards from us, accosts himself in rather a loud tone with "What, in the name of fortune, can that fellow be grubbing after?" No doubt you represent in his mind that very eccentric old fellow who, as sung by the author of the "Ingoldsby Legends,"—

"Would pore by the hour
O'er a weed or a flower,
Or the slugs that come crawling out after a shower.
* * * *
Still poking his nose into this thing or that,
At a gnat, or a bat, or a cat, or a rat,
Or great ugly things,
All legs or wings,
With nasty long tails arm'd with nasty long stings."

You are used to this sort of thing, and continue your dabbling in spite of it all. Now look into your bottle, and you will see several small, dark, round bodies, about the size of a pin's head perhaps; take three or four out, and examine them singly on your hand with your lens. "They are slightly convex on one side, and concave on the other." "Then they are of no use except as indicators; they are merely the separated discs or faces of old specimens; try again." "Now what have you?" "Why, a mass an inch long, and of an oval shape." "These agglomerated masses are to be depended on, so we will take them home, and in due time you will see them germinate." These little bodies are the product of the most beautiful of all the Fresh-water *Polyzoa*, and of one which is generally considered to be somewhat rare, viz., *Cristatella Mucedo*, the only locomotive species; for, unlike the rest of the family, *Cristatella* is unattached, and being possessed of a muscular base, strongly resembling the foot of a gasteropodous mollusc, the colony is enabled to move about, slowly, it is true, upon the surface of submerged weeds, stones, etc. But it is extremely difficult to detect the presence of adult forms of *Cristatella*, on account of their transparency, and the fact that they live for the most part upon weeds which

are generally covered with scum, and the faded filaments of Algæ of the same colour as the animals. Therefore, if you are desirous to learn whether any mill-pool or lake contains *Cristatella*, the better plan is to search for these round black bodies (which Professor Allman has designated *Statoblasts*) late in the autumn, or in winter, or in early spring, rather than for the mature animals. The same advice, too, will be found good in the case of other Polyzoa. These statoblasts are always to be found, and generally in very great abundance, floating in the water, so that all that is necessary is, to dip your collecting bottle in, or to skim the surface; the statoblasts are so characteristic of the different species to which they belong, that you can never doubt what kinds your pond supplies.

If, however, the fully-developed colony is the object of your search—I am speaking of *Cristatella*,—then in the months of June, July, and August you should visit the pond. And here let me give a bit of advice: lie flat down (the *Cristatellæ* are almost always within a few feet of the bank, covered by water varying from an inch in depth to about two feet), and with your eyes close to the surface of the water, and with as little disturbance of it as possible, gently clear away the floating weeds, and examine the submerged stems of the plants *in situ*, just as they grow in the water; it is of little use to pull the weeds out of the water, and then examine them, because it is almost impossible amid the convervoid growth which covers the plants to detect the collapsed form of your much prized *Cristatella*, so you must "stoop to conquer." Probably for a minute or two you will see nothing like the object of your search; but be patient, continue to gaze, and you will most likely be rewarded by observing, amid the scum and confervæ, an oblong-shaped feathery object, about one inch or more in length perhaps, of a pale yellow colour, bearing some resemblance to the well-known gelatinous egg nidamentum of *Limneus stagnalis*. This is *Cristatella Mucedo*, the queen of Polyzoa; and if you are not gratified at the sight of her extreme beauty, as you gently place her with the weed to which she is attached in your collecting bottle, and if you have not an intellectual treat over your microscope when you get home, it is clear you are no judge of beauty.

The attached forms of the Fresh-water Polyzoa are not nearly so difficult to find; at least, I speak of those species with which I am familiar—such as *Alcyonella fungosa*, very readily found and common everywhere, three or four kinds of *Plumatella*, and *Fredericella Sultana*. This last-named species appears to be a singular exception, in one respect, to the rest; for while they seem to be strictly annual in their duration of existence, *Fredericella* is perennial. At any rate, I have discovered it in mid-winter,

and at all other periods of the year; and that this species is perennial is rendered probable by the fact that the statoblasts are very sparingly produced when compared with the immense profusion yielded by other kinds. The attached forms of the Fresh-water Polyzoa are readily found, if the collector will patiently examine submerged branches of trees, or the under-side of leaves and stones; for the large sponge-like masses of *Alcyonella*, the branching tubes of *Plumatella*, and the tangled interlacements of *Fredericella* are apparent to the eye without an effort—though at the same time, perhaps, if he had never seen a single specimen, he would either not notice them or would fail to discern in them objects of much interest.

The Polyzoa afford a most instructive example of the necessity to pay particular attention to the internal structure and anatomy of any animal, if we would desire to ascertain its place in the animal kingdom. In external form the members of this group bear a very close resemblance to phytoid Zoophytes with which indeed they were long confounded. Now these latter animals belong to the low-organized class known by the name of *Hydrozoa*, of which the common *Hydra* or Fresh-water Polype, may be taken as the type. But the Polyzoa, notwithstanding their resemblance to, are widely separated from this group, and represent in their structure analogies with that section of the molluscan sub-kingdom happily designated by Milne Edwards *Molluscoida*. "You go down," says Mr. Kingsley, "to any shore after a gale of wind, and pick up a few delicate sea-ferns. You have two in your hand (*Sertularia operculata* and *Gemellaria loriculata*), which probably look to you, under a good pocket magnifier, identical, or nearly so. But you are told, to your surprise, that however like the dead horny polypidoms which you hold may be, the two species of animals which have formed them are at least as far apart in the scale of creation as a quadruped is from a fish."* The Polyzoa have now been admitted to their proper place in the animal kingdom, and have been advanced from the sub-kingdom Radiata (now *Cœlenterata*) to that of the Mollusca. "Thus," as Dr. Carpenter instructively remarks, "whilst microscopic research has degraded the Foraminifera from their supposed rank with the nautilus and cuttle-fish to the level of the sponge, it has raised the wheel-animalcules into proximity with aquatic worms and the humble 'sea-mat' (*flustra*), formerly supposed to be a plant, to a position not much below that of the oyster and mussel."†

The Polyzoa having an organization homologous with the

* Glaucus, p. 33.

† "The Microscope and its Revelations," p. 18, 2nd ed.

Ascidiæ, or tunicated Molluscs, are now accordingly included with this latter group, and form together the section Molluscoida, (the other section being the Mollusca properly so called). A glance at the illustrations will show the general resemblance which exists between a Polyzoon and an Ascidian, but for the determination of the precise homologous organs the reader must refer to Professor Allman's valuable monograph.*

In the Ascidian the respiration takes place by means of internal branchiæ; in the Polyzoon, by means of external branchiæ forming around the mouth a corona of tentacles ciliated and protractile. They have both a distinct digestive tube, which turns on itself and is open at both extremities; the nervous ganglion, though it does not occupy the same position in both animals, is of similar form and of a very rudimentary nature, and is regarded by Allman as a further instance of homology.† The most marked point of difference between the organization of a Polyzoon and a tunicated Mollusc consists in the latter animal being possessed of a heart and a vascular system, while in the Polyzoon no trace of anything of the kind exists.

It will be well now to obtain some general conception of a Polyzoon, which we shall be readily able to do with the figures before us (Plate XIII., figs. 1 and 2), and from the following clear explanation of them by Professor Allman:—

"Let us imagine an alimentary canal, consisting of œsophagus, stomach, and intestine, to be furnished at its origin with long ciliated tentacula, and to have a single nervous ganglion situated on one side of the œsophagus. Let us now suppose this canal to be bent back upon itself towards the side of the ganglion, so as to approximate the termination to the origin. Further, let us imagine the digestive tube thus constituted to be suspended in a fluid contained in a membranous sac, with two openings — one for the mouth and the other for the vent—the tentacula alone being external to the sac. Let us still further suppose the alimentary tube, by means of a system of muscles, to admit of being retracted or protruded according to the will of the animal, the retraction being accompanied by an invagination of the sac, so as partially or entirely to include the oral tentacula within it; and if to these characters we add the presence of two sexual organs in the form of ovary and testis, occupying some portion of the interior of the sac, and the negative character of the absence of all vestige of a heart, we shall have, perhaps, as correct an idea—apart from all theoretical considerations of homology or derivation from an archetype—as can be conveyed of the essential structure of a Polyzoon in its simplest and most generalized condition.

"To give, however, more actuality to our ideal Polyzoon, we may bear in

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* "On the Fresh-water Polyzoa." Ray Society, 1856.

† *i.e.*, Correspondence of parts.

mind that the immediately investing sac has the power, in almost every case, of secreting from its external surface a secondary investment of very various constitution in the different groups; and we may, moreover, conceive of the entire animal with its digestive tube, tentacula, ganglion, muscles, generative organs, circumambient fluid, and investing sacs, repeating itself by gemmation,* and thus producing one or more precisely similar systems, holding a different position relatively to one another, while all continue organically united, and we shall then have the actual condition presented of the Polyzoa in their fully developed state."

Now of these two investing tunics, the outer one is called the *ectocyst*, the inner the *endocyst*.† This latter tunic lines the interior of each chamber, and terminates in the tentacular crown (*lophophore*‡); it is transparent, and is readily seen in all the Fresh-water Polyzoa, both when the animal is protruded, and when it is retracted within its cell; for a portion of the endocyst always remains "in a permanently invaginated state." The ectocyst, in most of the genera, consists of a tough leathery substance, imbedded in which are silicious and other earthy particles. In *Fredericella* I have noticed that the silicious "frustules," or component cells of *Diatomaceæ*, especially those of *Diatoma vulgare*, enter largely into the composition of the ectocyst; *Cristatella* alone appears to be destitute of an ectocyst. The inhabitant of each cell is called a *Polypide*,§ a term wisely proposed by Allman instead of *Polype*, which should now be confined to the animals belonging to the Radiata; the whole dermal system of a colony is known by the name of *cœnœcium*.‖ The very curious valve-like organ, like a tongue, which arches over the mouth, and which all the fresh-water species, except *Paludicella*, possess, has received the name of *epistome*.¶ The presence or absence of this organ, whose function, by the way, it is difficult to determine, gives the name of the *order* to which the numerous species respectively belong. Those Polyzoa which are furnished with a bilateral tentacular disc, and whose mouth is provided with the tongue-like organ described above, are placed in the order *Phylactolæmata*,** to which are referred all the fresh-water species, except *Paludicella*, and none of the marine except *Pedicellina*; while the species destitute of an epistome, and which have a circular tentacular crown, belong

* *i.e.*, Budding.

† *Ectocyst*, from the Greek *ectos*, "outside," and *cystis*, a "bladder," or "bag." *Endocyst*, from *endos*, "inside," and *cystis*.

‡ From *lophos*, "a crest," and *phoreo*, "I bear."

§ From *polypous*, "a polype," and *eidos*, "resemblance."

‖ From *coinos*, "common," and *oicion*, "a house."

¶ From *epi*, "upon," and *stoma*, "a mouth."

** From *phylasso*, "I guard," and *laima*, "the throat."

to the order called *Gymnolæmata*,* which comprises nearly all the Marine Polyzoa. The space included between the endocyst and the alimentary canal is termed the *perigastric space*.

Let us now take a specimen of *Cristatella Mucedo*, and observe those other details of structure or economy which require consideration. You cannot select a better specimen for study than this beautiful species, which, unlike some of the other Polyzoa, is not at all particular, nor shy of being treated roughly. The Polypides protrude themselves most good-temperedly from the orifices of the cells, and if a sudden shock to their rudimentary nervous system causes them to contract within their chambers, they will pop out again almost immediately; while some of the *Plumatellidæ* are occasionally very shy in making their appearance. Sometimes you may be obliged to force the Polypides out of their cells in order to see whether they are alive or not, a fact which is easily ascertained by the ciliary motions of the tentacula.

The engraving (Plate XIII., fig. 3) is copied from a drawing, made by a friend, of a living specimen of *Cristatella* taken last July, and is magnified about two and a half diameters. The colony, which varies in length from between half an inch to about two inches, is of a long oval shape, yellowish in colour, with large dark spots, which are the statoblasts imbedded in the cænæcium, and with smaller ones which are pellets of fæcal matter. The upper surface is convex, and around the margin there are three regular concentric series of Polypides alternating one with another, while the central portion of the cænæcium is unoccupied. This arrangement is not seen in the drawing, because the portrait was taken soon after the specimen had been taken out of the collecting bottle, and before it had time to assume its normal position. The under-surface consists of a flattened muscular disc, by means of which the little colony attaches itself to submerged weeds, or moves along from place to place. The tentacula are very numerous, from seventy-five to eighty in number; they are hollow, and communicate with the lophophore and the perigastric space. The cilia, which are always seen to vibrate in an upward direction on one side of a tentacle, and downwards on the other, answer the double purpose of respiration and of supplying, by the currents they produce, food for the little inhabitants of the cell, which food consists chiefly of Desmideæ and the spores of Algæ.

The lophophore, in most of the Fresh-water Polyzoa, presents the form of a crescent, or a horse-shoe;† in *Fredericella* this

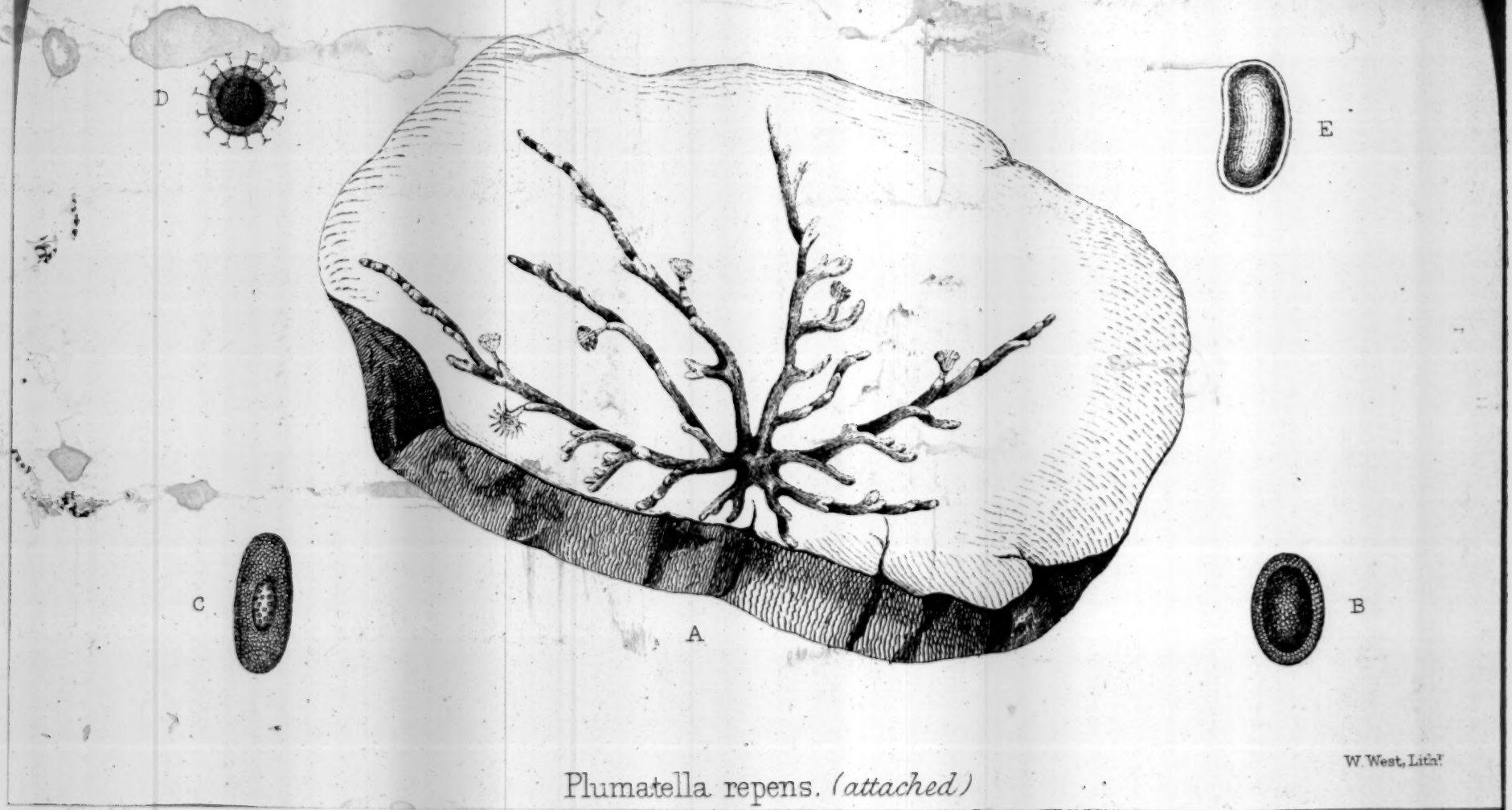
* From *gymnos*, "naked," and *laima*.

† Whence the term, *Hippocrepia* (*hippos*, "a horse," and *crepis*, "a shoe"), proposed by M. Gervais to designate the Fresh-water as distinct from the Marine Polyzoa, to which latter group he applies the term *Infundibulata* (funnel-shaped).

crescentic form is not at all obvious; but, according to Professor Allman, this species really presents no departure from this type, though the arms of the crescent are obsolete. The digestive tube consists of mouth, œsophagus, cardiac and pyloric cavities of stomach, intestines, pylorus, and anus. The muscular system is well developed; Allman describes eight different kinds, the most obvious of which are (1) the powerful retractor muscles by means of which the entire Polypide is drawn within the cell; (2) the rotatory muscles of the crown, whose action it is to rotate the crown and depress the lobes; (3) the anterior parieto-vaginal muscles, by means of which the invaginated* endocyst is dilated, and kept permanently inverted; and (4) the posterior parieto-vaginal muscles, whose action "steadies the sheath, and regulates its position during the protrusion of the Polypide."

The Fresh-water Polyzoa increase by true *ova*, by *gemmæ*, and by *statoblasts*. The ova, which are formed in a true ovary after escaping into the perigastric cavity, are there most probably impregnated by the free spermatozoa; but how the ciliated embryo escapes from the cells it is not easy to determine, seeing that no orifice has yet been detected through which it might effect an exit. The gemmæ (or buds) originate in the endocyst as small tubercles which project into the perigastric space, but soon appear as little vesicles projecting from the exterior of the parent cell; in these vesicles the Polypides are gradually developed. The points at which the vesicles sprout forth, determine, of course, the ultimate form assumed by full-grown specimens. The statoblasts are bodies of a very peculiar kind (see Plate XIV., figs. *b*, *c*, *d*, *e*), which are produced as small buds upon the posterior *funiculus*, *i.e.*, a curious cord-like body attached to the base of the pyloric cavity of the stomach at one end, and to the testis at the other. At first these statoblasts are colourless and almost transparent; in time they assume a dark brown colour, and acquire a leathery consistency, when they separate from the funiculus and fall free into the perigastric space, where it is probable they remain until they can gain an exit when the Polypide dies, and the destruction of its soft parts allows an escape through the orifice. This, I believe, is the only way of accounting for the escape of the statoblasts in most of the genera, as Professor Allman is convinced; but in the case of *Cristatella* the statoblasts remain clustered together by their marginal spines, and are not emitted singly; on the destruction of the tissues of the colony they are liberated, and either float on the surface of the water or attach themselves to submerged weeds.

* *i.e.*, sheathed, or drawn backwards into itself, as may be done with the finger of a glove.



W. West, Lith.

Plumatella repens. *(attached)*

The young animal makes its appearance in the spring of the year as a single Polypide, which, however, quickly produces others, until the colony attains the size of one or two inches by July and August, at which time there may be found an immense profusion of statoblasts in most of the genera.

The Fresh-water Polyzoa may be kept alive in a vessel of water for two or three months if care be taken to supply them with abundance of food (for they are voracious feeders), and to keep them well shaded from the light, for all the species, except *Cristatella*, love dark habitations. I have found *Fredericella* the most long-lived in an aquarium. As an instance of the capacity of a Polyzoon's appetite, I may record that a few years ago my aquarium was almost as green as pea-soup from the abundance of algæ spores; I put a good sized specimen of *Alcyonella fungosa* into the water, and in about an hour's time it was quite clear.

Most of the Fresh-water Polyzoa prefer clear lakes and mill-pools, but *Alcyonella* is by no means so particular, being found in water where there is much mud; *Alcyonella fungosa* assumes a spongoid form and grows to a very large size; the interstices of the cænæcium harbour a multitude of all sorts of aquatic animals, Annelids, Crustacea, and the larvæ of various insects, &c., &c. It is advisable to pay attention to these hosts of *Alcyonella*, as some few years ago I was rewarded by the discovery of a very rare worm, whose occurrence in this country rested on doubtful evidence; this was the Fingered Nais (*Proto digitata*), which protruded the curious digitiform segments of its tail out of the mass of *Alcyonella fungosa*.*

The Fresh-water Polyzoa have not been studied in this country at all as they deserve; it is true that we have Allman's admirable monograph of this group, in which work all known species are described and figured; but it is probable that careful searches may reward the collector with the discovery of new species, while his observations may tend to throw light on some points of their economy which require elucidation.

Professor Allman enumerates sixteen *British* species, and believes the number of known species to amount to twenty-one. It is curious to notice that until within the last few years not a single species of Fresh-water Polyzoa had been discovered south of the Mediterranean in the Old World, or of Philadelphia in the New. In 1860, however, Mr. C. D'Oyly H. Aplin found several specimens of this family, comprising at least two species, in Australia. One specimen he described† as having elongated

* See "Annals and Magazine of Natural History," Dec., 1860, p. 393.

† Ibid, p. 454.

statoblasts, closely resembling Allman's figure of *Plumatella emarginata;* the other was unlike any figure in that gentleman's monograph.

According to Dr. Fritz Müller ("Archiv fur Naturgesch." 1860, p. 312), there exists in some of the marine members of this group a *colonial nervous system,* in addition to the individual nervous system alluded to above. By means of this colonial system the movements of the general body are controlled. It is quite probable that careful microscopic examination may result in the discovery of a similar organization in *Cristatella,* and other fresh-water species.

EXPLANATION OF PLATES XIII. AND XIV.

PLATE XIII.—Figs. 1 and 2. Plan of a Polyzoon: (1) exserted, (2) retracted.

Fig. 1. *a*, mouth and tentacles; *b*, alimentary canal; *c*, anus; *d*, nervous ganglion; *e*, investing sac; *f*, *f'*, reproductive organs; *g*, retractor muscle.

Fig. 3. *Cristatella Mucedo.*

Fig. 4. Plan of an Ascidian Tunicate. *a*, triple investing sac; *g*, respiratory apparatus; *n*, mouth; *o*, œsophagus; *p*, stomach; *q*, intestine; *r*, anus; *u*, nervous ganglion; *v*, heart.

Fig. 5. Plan of a Fresh-water Polyzoon, showing homologous parts with Fig. 4. For explanation, see Fig. 1. Figs. 1, 2, 4, 5, after Allman.

PLATE XIV.—*a*, *Plumatella repens,* attached to a stone (natural size); *b*, statoblast of ditto; *c*, ditto of *P. fruticosa*; *d*, ditto of *Cristatella*; *e*, ditto of *Fredericella Sultana*; (all magnified).

THE AFRICAN LION IN ITS NATIVE HAUNTS.

BY JULES GERARD (THE "LION KILLER").

Translated by the Editor.

THE title of this Journal has induced me to lay before its readers a few observations on an interesting subject in natural history, the treatment of which might perhaps be deemed too popular for any of the scientific periodicals which have higher pretensions than it puts forth to erudition and abstruse investigations; and I trust that these remarks may be the means of calling more general attention to the history of that noblest of creatures, the Lion, than it has hitherto enjoyed in this country.

My observations possess, at least, one advantage,—not an unimportant one in these book-making days,—namely, that of originality: for they are not merely a narrative of what others have seen, or a repetition of what my predecessors have written, but are the results of my own personal experience. My knowledge of the lion's natural history has been acquired in those wilds of which he is the sovereign ruler. I have met him face to face as he approached the encampments of the unfortunate Arabs in search of his nightly meal, have tracked him to his lair on his return from his depredations.

These adventures I have described elsewhere, in a form more suitable for the general reader;* but it is now my intention, as far as the limited space allotted to me will admit, to recall a little of the more solid information which I have obtained during my hazardous expeditions, for the benefit of those who read rather for instruction than for amusement.

Let me first mention, that the result of my observations has led me to conclude that the race of lions inhabiting the northern portions of the continent of Africa is superior to those which are met with in the western and central parts of that continent.

Whether this superiority be inherent,—that is to say, an original quality of the animal,—or whether it is due to the conditions by which the creature is surrounded, I shall not venture to say; but shall be content to substantiate the truth of this assertion by illustrations of its superiority, leaving it to the consideration of better-informed naturalists to fathom the *cause*.

* "Le Tueur de Lions." Paris; J. Vermot.

The western, central, and eastern portions of Africa have each a variety of lion. The first, which is found between the borders of the Great Desert as its northern limit, and down to the lower basin of the Niger in the south, is a maneless creature, of an elongated form, and whose height is about that of the tiger, with which animal, moreover, it has many points of resemblance.

This variety is a hunter; that is to say, it procures its nourishment by chasing game. For this purpose its instinct teaches it to combine with its congeners in the pursuit of its prey, which is effected under the direction of a veteran leader, who allots to all their proper posts and duties: to the most active and best armed the places of danger, whilst the lionesses and young ones are detached for the purpose of beating the game. By combined action,—nay, it might almost be said by a strategic movement,—the lionesses and their young press forward in an unbroken rank; and, just as in a battue, they drive before them all the animals within their circuit in the direction of the hunting party, their movements being accompanied with a loud clamour. When the prey arrives at the passages guarded by the elders, these spring upon and slaughter it with great rapidity, and probably with little suffering to the victims. Should, however, a rhinoceros or an adult elephant form a portion of the quarry, it is either allowed to pass unmolested, or is brought to the ground by the united attack of several lions. The battue ended, each hunter takes his share of the booty; not, however, without some slight privileges in favour of superior might, which in the lion-world also (in this instance, at least,) constitutes *right*.

When, for example, the chase has been successful, and a great number of animals are slain, no disputes arise concerning the division of prey; but should it happen that there is not sufficient to satisfy the appetites of all, the arrival of the lionesses is awaited, and these are first served: then comes the turn of the males; and lastly, upon the remnants—should there be any—the young people are permitted to regale themselves.

Sometimes, when he grows old, the lion of this district turns misanthrope, and flees from the company of his congeners. In such cases, not being able to take a part in the battues of the community, nor to provide himself with sufficient nourishment by hunting the animals of the forest alone, he becomes a man-eater. Taking up his quarters in the thick brushwood bordering on some village, he seizes the natives in their passage to the fields; and it is not at all uncommon for the traveller to find villages in the basin of the Gambia and Niger abandoned by their inhabitants from this cause.

In these habits, then, and in its elongated shape, the mane-

less lion of Africa manifests a resemblance to the tiger, and more especially to that of Bengal.

The lion of Central Africa with which we are acquainted appears to belong to the same variety found even as far south as the immediate vicinity of the Cape of Good Hope. It is adorned with a beautiful mane, the disposition of which, falling as it does far over the animal's forehead, detracts greatly from its appearance. This defect, and the elongated form of its jaws, deprive the animal of that majestic air which characterizes its congener in Northern Africa.

The third variety appertains to Eastern Abyssinia, Sennaar, and Upper Egypt, and is distinguishable by its form and colour. With a body thick-set as that of a bull-dog, and fierce and sullen as the latter, this lion would be dangerous in the extreme if it were endowed with strength proportionate to its other qualities. Fortunately for the natives, however, he is small, and possesses nothing formidable beyond his red covering and his vicious disposition.

Dismissing these three varieties of the lion with the foregoing brief comments upon their appearance and habits, I shall now ask my readers to accompany me over the orthodox geographical route across the Great Desert to Northern Africa—a journey more easily accomplished in the reader's company, and on paper, than over the burning sands and under the tropical sun of Africa. This expedition will enable us to make the assertion that the "Lion of the Desert," which has been so frequently described, has no actual existence; and it requires but little consideration to show why the animal is not to be found in that locality. Three things are indispensable to its existence—fresh meat, pure water, and shade for repose. Now, from Timbuctoo to the first oases which are found north of Soudan, there is a distance of not less than 400 or 500 miles to be traversed without the existence of this threefold condition of life for the lion; and the country east and west along its whole length is of precisely the same character. It will therefore be easily understood that no lion could penetrate into, much less establish itself permanently in these desert regions. Beyond this sea of sand, however, and the few fertile islands, the verdant oases which are scattered over it, we come to the great chain of Mount Atlas, which, with its magnificent ramifications, is nobly peopled with denizens of the animal kingdom. Here it is that we find the African lion *par excellence*—the lion of Numidia.

Kazouïni and Dameïri, two Arab authors anterior to Buffon, have described the lion of Northern Africa in glowing colours. Their account commences with the titles of nobility of these large-headed sovereigns of the wilds. He is the "great," the

"generous," the "magnificent," the "formidable," the "conqueror," the "irresistible," the "gallant," the "superb," the "invincible," the "devourer," the "courageous," the "intrepid," the "roaring," and eighty-nine other attributes in his praise, being but one short of the number which they accord to the Almighty.

Dameïri subsequently describes a conflict in which he took part between a host of Arab warriors and a single lion. In this affray more than one hundred men and as many horses were placed *hors de combat*, and the lion, pierced with wounds, remained master of the battle-field, the king having given way before so noble and courageous an animal.

This high estimate of the Numidian lion, published many centuries back, accords with the facts which I have collected, and my own observations at the present day.

I have, however, found in Numidia, not one, but three well-marked varieties of lion; and I presume it is in honour of the most formidable of these that the Arab chronicler has recited his narrative. The three varieties of this interesting family known to me are the *fawn-coloured*, the *grey*, and the *black*. Amongst the Arabs they are known as "el Asfar," "el Zarzouri," "el Adraa." The fawn-coloured and grey varieties are bold animals, far superior in external form and muscular strength to their other African congeners, and also dissimilar in their habits.

These great lords hold the principle that to hunt game is a fit employment only for poachers and peasants; and, after the manner of certain barons of the middle ages, they deem it more dignified and convenient to support themselves at the expense of their vassals. Every man, therefore, who stands possessed of a herd of oxen, a flock of sheep, or of a few horses, is, in their opinion, amenable to the levy of tithe and tribute.

Starting upon this axiom (still uncontroverted), the lion just referred to awakes at sunset, and coolly proceeds to some rock in the vicinity of his lair to perform his toilet; and from whence, looking down upon his territories, he can survey the whole surrounding plain, and perceive the various flocks and herds returning to the fold.

When night has fairly set in, he rises to his feet, roars for the first time, and swaying his enormous head from side to side as he proceeds, makes his way with measured pace towards the encampment which is to furnish him his supper.

The very roar of the lion in its wild state, which is a music that even the most fastidious would deem worthy of being listened to, is truly magnificent. His first note, when he commences to roar, is a low sound emitted from the chest and nostrils; but it is audible from a great distance. This is a

species of prelude, and immediately afterwards it is repeated, but this time it is much louder and more protracted; the jaws of the animal being still closed, or the mouth but slightly opened. The third and fourth outbursts are given to the air through the fully extended jaws, and with the whole force of the lungs. To listen to this roar is terrible for those who happen to be crossing the monarch's path, or to be marching through the lonely forest. At length, after two or three more utterances of this kind, the animal ends, as he commenced, with less vigorous notes.

The distance to which I have been able to trace the progress of a lion by his roar, when there has been no contrary wind, and no mountain nor other obstacle to intercept the sound, is two or three leagues; but when he roars about a league off, one who is unaccustomed to the sound would believe him to be close at hand.

A curious circumstance which I have noticed, is that when the lion is accompanied by his mate they always roar alternately; that is to say the lioness commences, and the lion answers her, each continuing in its turn to utter its note, but the tones never being mingled. It has afforded me some satisfaction to find that my hero possesses a musical quality, which has never been observed in any other quadruped, so far as I am aware; and I am quite content to leave it to men of science to discover the cause, should they deem the matter deserving of their attention.

But to return to our hungry lion, whom we left descending from his mountain lair to the plain on which the encampments are pitched. By the term "encampment"* the Arabs and natives of Barbary designate an assemblage of tents ranged in a circle, and in close proximity with one another, except in one part, which serves as a passage to and from the plain. In the centre of this circle the herds are penned; and the external enclosure which surrounds and serves as a protection to the tents, consists of a rude hedge from six to twelve feet in height. The aperture or passage referred to is kept open during the day, but is closed at night.

When the Arabs hear the lion begin to roar in the distance they are at once on the *qui vive*. Heaps of wood are piled up before each tent and kindled, so that when the lion arrives near the encampment he may be visible to all, and that the owner of each tent may be able to throw a lighted brand at his head, and drive him forward to his neighbour's tent.

But the king of beasts is so much accustomed to these fires and to the cries of men, women and children, joined with the

* "Douar."

yells of dogs, that he completely understands their meaning, and regards them with perfect indifference. Like an experienced hunter when he arrives before a hedge, all he does is to take the measure of its height with his eye, and then with a bound as quick as lightning he clears it, and alights in the encampment.

Then follows a scene of unutterable terror and confusion. Men, women, and children rush pell-mell into their frail dwellings. The dogs are silent in an instant and seek refuge on the tops of the tents; with desperate struggles the horses break their tethers, and all the large cattle, forcing a gap in the hedge which encloses the encampment, scamper across the plain. The poor sheep, too much terrified to flee, are huddled together in a heap and bleat most lamentably, as though pleading for mercy. But the lion has left his generosity in the mountains, and at this juncture he experiences only his carnivorous instincts. These prompt him to take possession of one of the poor sheep, unless on this particular occasion he prefer to regale himself with an ox or a horse; in which case he pursues the cattle into the plain and commits fearful havoc amongst them.

For, a single victim on one night is not sufficient to satisfy this long-maned gourmand. He needs an ox for his dinner, partaking only of the prime portions, and afterwards the blood of five or six more serves to quench his thirst.

Thus far, we have no right to object to the lion's proceedings. We drink claret, beer, and champagne; he prefers the warm blood of his victims—every one has tastes given to him in accordance with his nature. But the really objectionable part of his proceeding is, that he does not return to devour the animals he has slain, but goes elsewhere and massacres new victims. This need of fresh-killed meat occasions enormous losses to the Arabs, for their religion forbids them to feed on animals which have not been killed by themselves, pronouncing, in so doing, the sacramental words "*bessem Allah*" (in the name of God).

This is the mode of procedure with the grey and fawn-coloured lion when it seeks its meal alone; if accompanied by his mate, the latter remains outside of the encampment, and her lord, clearing the enclosure, manœuvres in such a way as to drive a portion of the cattle to the locality where she is stationed. Madame selects her victim, slaughters it adroitly, and at once sets about her meal, never permitting her spouse to partake of her repast. Neither does he attempt to touch one of the slaughtered animals which lie around, but looks on patiently until his spouse has finished her meal: his behaviour, let me add, serving as an example worthy of imitation by all married men. I have even noticed, that when he approached

his mate, apparently with a view to inquire whether her food was palatable, she would respond to this delicate attention on his part by demonstrations of anger, without at all, however, disturbing *his* serenity.

But the excellent domestic qualities of the wedded lion do not end here. When he has attained the felicity of being the parent of two or three young ones (the average number of young in the family of a pair), he is charged, during the day-time, with watching over the safety of all, and at night it is he who sets out to the distant plains in pursuit of prey, to furnish sustenance to the mother and her young cubs.

In the performance of this duty, the lion has recourse to an expedient well worthy of the consideration of scientific men, and calculated to puzzle those who disbelieve in the magnetic power of animals. As the lair inhabited by the lioness and her young is always at a considerable distance from the Arab encampments, it would be a difficult task for the lion to carry, or even to drag, an ox or a horse so far. To avoid this labour, he brings home a living animal. Yes, reader, incredible as it may appear, the lion possesses the power of compelling a bull to leave the herd, and can force it to precede him, in whatever direction he pleases, for a whole night, thus leading him into the most inaccessible mountains.

Let me relate a circumstance connected with this power possessed by the lion, of which I was myself an eye-witness, my rifle having on that occasion solved the strange problem:—

In the month of May, 1846, an expedition set out from the camp at Guelma towards the frontiers of Tunis, for the purpose of chastising a rebellious tribe of Arabs.* At seven in the morning of the second day of our march we arrived at the banks of a river called El Meleh Salée, which flows past the foot of a bare precipitous mountain. At this place we halted, and Captain (now General) de Tourville ordered the cavalry to remain until the infantry and baggage had passed over the hill. We had been there about an hour, when we saw a horseman gallop back to us at the top of his speed. This horseman was a spahi, who formed part of the escort, and having reached the leader of the cavalry, we saw him address him with great animation and many violent gestures, which led us to believe that the vanguard had been, or was about to be attacked. Presently, however, I heard my own name frequently repeated, as though some one was wanted on a pressing service. I has-

* M. Gérard was then, and is still, an officer in the French army. His early life, and lion-hunting adventures are described in his work, already referred to, "Le Tueur des Lions." A few lines concerning him will be found at the end of this paper.—Ed.

tened to join our commandant, and this is what I learned from the Arab—his statement being received with the utmost incredulity by those who stood around:—

At the moment when the head of the column had reached the summit of the hill, the vanguard perceived a bull approach across the corn-fields, and behind it, only a few paces distant, was an enormous lion which followed its footsteps. The soldiers at once set up a great cry, the drums were beat, and the clarions sounded. This noise arrested the animals for a moment, and then they proceeded onwards, in the direction of the troops. As they were not above a hundred paces distant the men prepared for a volley, when the commander and officers gave orders not to fire, but to halt.

The bull and lion crossed the path on which the troops were about to march, within pistol-shot; the lion then lay down to survey this spectacle which was so new to him, and the bull commenced grazing close by his side.

It was at this juncture that the spahi was despatched to fetch me; and it is hardly necessary to say that, notwithstanding the distance and the difficulty of the road, I was not long in reaching the scene of the strange apparition. The lion was, however, no longer there, and I had to follow his track. On arriving at a little hillock I saw him on the slope of a mountain opposite, still preceded by his victim. Having heard the gallop of my horse and that of the spahi who accompanied me, the lion had stopped, and was watching our approach.

The bull had followed his example. When I had arrived at about a hundred paces from him I dismounted and walked towards him, preparing my rifle. The lion politely advanced to meet me, and when we were distant from one another about twenty-five or thirty paces I stopped, and fired my first ball, which turned him on his back. He, however, rose instantaneously, and with furious roars bounded towards me. More fortunately or skilfully aimed, my second shot stopped his infuriated career in time, and brought him to the ground.

As for the bull, he was led to the bivouac the next day, and I ascertained from the Arabs of the district in which we were, that he belonged to an encampment situated at least twelve miles distant from the locality in which we had encountered him; and that each night of the previous month had been marked by an abduction of the kind, the victims serving as food for a lioness and her cubs which inhabited a neighbouring lair.

I confess that when I heard this news, I regretted the mischief which I had unconsciously occasioned. My readers will doubtless consider the care and affection manifested by the lion towards his mate and young ones as laudable as I do; and

as to the question of magnetic influence, I can only explain it on the ground of extreme terror; for there are many examples cited of Arabs thus magnetized and led away by the lion, in the presence of other persons who had sufficient presence of mind not to succumb to his influence.*

The variety of lion to which I have been referring is, in every other respect, a pattern of domestic virtue, which is more than can be said of his mate; but as I have now almost reached the limits of the space allotted to me I must leave them to settle their differences, and conclude this brief and imperfect account of the habits of the king of beasts with a few remarks upon the last variety, the black lion, which is the finest and most formidable of the species.

This animal is not so common as the fawn-coloured or the grey one. Like the two latter, it takes six or eight years to arrive at its full growth, and its life is of fifty or sixty years' duration. With somewhat shorter legs, it is broader and more thickset than they are. The power of its jaws, chest, loins, and paws is so great, that it can clear an enclosure eight or ten feet high with a horse three years old between its teeth. I have myself witnessed this feat on more than one occasion. His habits pretty much resemble those of the two last-named varieties up to the age of twenty or thirty years, but then he becomes a man-eater, and causes terrible ravages on the frontiers of Tunis and Morocco, where he is the most frequently met with. The courage of this lion is really grand. It matters little to him by what numbers he is attacked, and whether it be by day or by night, he never flinches. I have seen one of these black lions charge into the midst of 300 Arab horsemen on an open plain, and drive them back almost to their encampment; the boldest of them with their horses remained prostrate along his path. I have sometimes found the grey or fawn-

* It is not our intention to enter upon the discussion of the subject of the fascination exercised by animals over their prey; but we may mention that there are many instances on record of a somewhat similar power being possessed by other animals. An anonymous writer, in the "Leisure Hour" (Nov. 1862), gives some examples of it in the stoat: he watched a rabbit trying to escape from the fascinating power of a stoat, around which it circulated, as if spell-bound, "continually narrowing the circle in which it was running, whilst the stoat seemed to be watching for it to come near enough to spring at." The narrator shot the stoat, and the rabbit then escaped. If, in our author's case, the bull had made an effort to escape when the course of the lion was arrested, it would have been easy to explain the fascination on the same ground as in the case of the stoat and rabbit. We would also draw attention to the remarks on this subject in the review of Hartwig's "Tropical World" in our present number.

coloured lion hesitate when I met him at night on my expeditions through the forest, but never this one. The black lion always looked me full in the face, without any demonstration of anger, before the attack, but regarding me with disdain, as if I were an inferior being. In fact he is the most *beautiful* animal *before*, and the *noblest after*, man himself.

Fortunately for him, he has not yet become acquainted with the martyrdom of captivity, for I cannot otherwise designate the cruel and thoughtless mode of securing him in zoological gardens.

Here is a creature which, more than any other, has need of air and space, and he is imprisoned in a cage in which he can hardly turn himself. But the money requisite to supply the place of those which thus die a miserable death would amply suffice to afford them an extent of ground similar to that reserved for deer and other less noble animals; and we should then possess creatures magnificently proportioned, instead of poor, sickly, emaciated forms; and they might be watched as they play and bound in fact almost as in a state of nature.

There is still something to be done in this respect, and sooner or later it will be accomplished, for the English are an earnest, practical people. Meanwhile, should any of my readers happen to be Fellows of the Zoological Society of London, I would just give them a friendly caution against making the mountains of Africa the scene of their vacation tours, lest the lions at large should take vengeance upon them for the unfortunate fate of their brethren held in captivity.

The author of this paper, M. Jules Gérard, is but little known in England; and it is only recently that his name has appeared somewhat prominently in connection with his lion adventures in Northern Africa, and his projected journey of exploration into the western equatorial territories of that continent.

The following details will, we trust, have the effect not only of giving additional interest to his little essay here published, but of enlisting for him the sympathies of our readers in his hazardous enterprise.

M. Gérard is an officer in the Franco-African army; but his recent reception here, and the object which he is now seeking to attain with English co-operation, are likely to associate his name with this country more intimately than with Northern Africa, the scene of his lion-hunting adventures, or with his native land.

He left Liverpool in excellent health and spirits, on the 24th of last February, by the steamer "Macgregor Laird" (a name

of good omen, as he said before leaving), for Lagos, accompanied only by a photographic assistant; and from that place it was his intention to proceed to Whidah (where the slaves are shipped), and thence through the possessions of the cannibal King of Dahomey to the river Niger.

We hope to be able to communicate further details of his route in a future number; meanwhile, we may mention under what circumstances he set out.

His reputation for bravery preceded him from France, and gained for him the goodwill of every class of society. Sporting men, from noble dukes downwards, made him their companion and friend. The Ministers of Foreign Affairs and of the Colonies, the merchants of Liverpool, the manufacturers of Manchester, and scientific men in every place that he visited, lent him their aid, "material and moral;" and before his departure, the Royal Geographical Society presented him with a set of excellent instruments to enable him to take accurate observations on his geographical tour.

But it is chiefly to the friendship of the Duke of Wellington that he owes his good fortune, and if it please Providence that another adventurous and high-minded man should penetrate into the gloomy regions of cannibalism and the slave-trade, and that he should do something to mitigate the horrors of these most fearful of human crimes, much of the result will be due to the prompt and generous support afforded by his Grace* to our author, nay, we may say our hero, at the most critical period of his projected undertaking.

As M. Gérard is not here to read our eulogium (for that he is as modest as he is brave all will say who know him), we may state that he is in every respect peculiarly fitted for his mission. As far as a somewhat brief acquaintance has enabled us to judge, he combines with the courage and determination of a soldier a gentle disposition, (which was pained when he found he had deprived the lioness and her young of their protector), scrupulous honour, French politeness, and English friendship; and if a good shot, an unbending will, and the winning ways of a man of the world be of any avail, M. Gérard will command as friendly a reception from his Majesty of Dahomey as he has experienced in civilized society in England.

When he started, he spoke with great confidence of the establishment of a colony and trading station in some healthy portion of the interior of western equatorial Africa, and we trust that in the cause of civilization and progress, as well as for his own sake, his enterprise may be carried to a successful issue.

* Also by Earl Russell and the Duke of Newcastle.

BRITISH FUNGI.

BY MISS MARGARET PLUES.

"The turf
Smells fresh, and rich in odoriferous herbs
And fungous fruits of earth, regales the sense
With luxury of unexpected sweets."

COWPER.

IT is a very general complaint during the autumn and open winter weather that there is nothing for botanists to find, and therefore no encouragement for them to extend their rambles beyond the dry limits of that most wearisome of all exercises, a "constitutional walk." Those who thus decide, do a grevious wrong to a large and curious race of plants, whose structure is as wonderful as that of the gayest exotics, and their colours in many instances scarcely less brilliant, and which have their uses too, both medicinal and gastronomic; also—what is generally most attractive—their dark and mysterious dangers. The Fungi are an ill-used race; under the name of Toadstools we insult them from earliest infancy. Flowers are often ruthlessly plucked, quickly to be cast aside and forgotten. Ferns, though the rage of the day, sometimes share a similar fate, and the mossy garland or basket is left to wither unnoticed; but such an end is too good for Fungi. "Ah, nasty Toadstools!" we say, and proceed to *kick* them over. Yet nowhere can we find more variety and purity of form, or more brilliancy of colouring. Let us do justice to the Fungi, examine their merits—ay, and their demerits too,—and then the woods will not lose their charm for us in autumn, nor even in winter.

Fungi, like most other plants, have three parts: *spawn*, which performs the function of roots; *expanded portion*, as the stem and cupola of the Mushroom, the branches of the *Clavaria*, or the cup of the *Peziza*, which answers to the stem and leaves of other plants; and *spores*, which answer to their fruit. The whole substance of a Fungus is formed of *cells*, generally round or oval, but often, as in moulds, branching in the most fanciful manner.

The order of Fungi is divided into two groups, or sub-orders: *Sporiferous*, where the spore is formed naked *upon* the cells; and *Sporidiferous*, when it is formed *within* the cell, which then becomes a bag, or spore-case. The first group of

Plate
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W West lith.

the SPORIFEROUS Fungi is distinguished by the *hymenium*, or *fruit-bearing part*, being open to the air. Our common Mushroom is a familiar example of this group, and stands as a representative of the large family known as *Agarics*. These have a cellular stem, a *pileus* (cap), resembling the top of an umbrella, and *lamellæ* (folds) underneath, upon which the cells are disposed, the spores springing from them; these lamellæ form the hymenium. In our autumn rambles we frequently come upon brilliant scarlet mushroom-shaped Fungi, their gaudy tops all flecked with white. These, as well as the Common Mushroom, belong to the Agaric group. They are enveloped in infancy in a *volva* (wrapper), which tears away as the pileus expands, leaving pieces like white felt adhering to the crimson covering. This *Amanita muscifera* is highly poisonous, and is used to make fly-poison in Britain; but it is employed in Kamschatka to make an intoxicating drink. It thus exhibits a peculiarity, not rare in its class, of the qualities being wonderfully altered by climate. Many species, deleterious in their properties here, are wholesome in Italy, and the Fuegians are nourished by some which to us would be wholly poisonous. A nearly-allied species (*Amanita rubescens*) with a brown pileus, but flecked in youth with scraps of its discarded volva, I have found in Kent and Yorkshire; its *flesh*, the substance between the pileus and the lamellæ, turns red when it is broken: hence its name.

The spores in this portion of the Agaric group are white. You may procure them for examination by leaving the young plant on a piece of coloured paper, where it will shed its spores. It is easy to examine them with a botanical microscope; their shape and colour at once decide the species. Under fir-trees in autumn I have frequently seen crowds of stately Fungi of this Agaric type, the brown coating of the pileus torn into shreds. This is the *Lepiota Rachodes*; it is round at first, but on reaching maturity the pileus expands, and becomes flat; the thin shreds, which formed a *velum* (veil) in youth, stretching from the edge of the pileus to the centre of the stem, still hang as a frill on the latter, and, along with the white spores, fix its position early in the Agaric group. The White Agaric, which grows in clusters on tan in hothouses, is another Lepiota.

In similar localities to that chosen by the *L. Rachodes*, we find the mouse-coloured *Tricholoma humilis*; the folds are prettily turned where they meet the stem, and tinged with the colour of the pileus, and the velum is hairy. Frequently in woods and field-borders groups of smaller violet-coloured Agarics are seen, the pileus covered with plum-like bloom. The lamellæ are also violet-tinted, and the pileus often twists into eccentric shapes. This is the *Clitocybe laccatus*. I remember being greatly attracted by a group of the salmon-coloured *Collybia*

Fusipes, growing out of the bole of a tree in an enclosed part of Hope Park, near Edinburgh. I fee'd a "laddie" to climb for them, and admired their umber inflated stems greatly when in my hand. A few of the stems were long, and had burst with the wet, showing their hollow structure. The lamellæ were pale yellow. An allied species (*C. Velutipes*) is common on stumps in woods, the velvet-like texture of its dark-brown stem forming a pleasing contrast with its orange cupola-shaped pileus; while myriads of the fragile mouse-coloured *Mycæna alcalinus* cluster on the same rotten stump, quivering in every breeze, and perishing by dozens as you try to gather them. Some of this numerous clan of Agarics are without a stem altogether, as the little lead-coloured *Pleurotus applicatus*, and the pale-brown biting *Panus stypticus*.

Turning from the Agarics with white spores, we are next presented with a group bearing salmon spores. The little brown "toadstool," with pileus no bigger than your finger end, which you find on lawns, *Naucaria melinoides*, is one of these. Our friend the Mushroom, *Psalliota campestris*, has purplish brown spores. It is said that sheep eat the Mushroom; and I remember being earnestly warned by a countryman not to eat any Fungus I gathered in a field where sheep were; "for it can't be the right kind, or they would have eaten it up," he said. The merits of this friendly Mushroom are numerous; to us it alone redeems its tribe from a great part of the stigma resting upon it. Stewed or made into ketchup, or pickled in the infant or "button" state, who can praise it sufficiently! And then the pleasure of going out mushroom-gathering, basket in hand and emulation in the heart; of wandering through the breezy pastures, reconnoitring from the tops of gates for white cupolas, and being quizzed unmercifully should they turn out to be lumps of chalk!

Who is there that has not noticed the cone-like Fungi springing suddenly after rain upon the lawn, often pressed so closely together as to push each other sadly out of shape? These vary from the typical Agarics in their lamellæ melting away, so that the spores flow away in the liquid substance of the folds, leaving, in the place of the *Coprinus atramentarius*, a mere stain, as of ink, upon the sward. Closely allied to this, though varying greatly in appearance, is a tiny Fungus which takes up its abode on the plaster of dwelling-houses. I was much puzzled on one occasion to find a starry network on my bedroom ceiling; it was as if threads extended in every direction from a round nucleus in the centre, like a flattened pea, and branches issuing from the threads, and interlacing wove the whole into a circular network. The little plant in the centre was the *Coprinus radians;* the branches, etc., were mycelium (spawn)

thrown out to draw moisture from the air for that nourishment which the plaster could not afford. A watery texture marks the sub-genus *Hygrophorus*, but they do not melt entirely away like their relative the *Coprinus*.

The green-tinted Agarics which adorn the sward upon the chalk downs belong to this family (*H. psittacinus*), as do also the gaudy orange conical ones which flourish in meadows in autumn (*H. conicus*). These same chalk downs are the grand *locale* for the *Marasmias oreades*, the mysterious cause of those fairy rings concerning which so much romance and sentiment has been told and sung. It is a pale, unassuming looking fungus, and perfectly wholesome; but who would like to dine on fairy rings! Surely, as a just punishment, they would be bewitched, and, at the least, pixy-led. Yet this very plant used to be sold in a dry state in Covent Garden Market.

Varying from the true Agarics in having the hymenium in *veins*, instead of upon lamellæ, the group of *Cantharellus* is yet very nearly allied to them. The Chanterelle, once so much prized, and still used in France, is frequent in our woods from Berkshire to the Northern Highlands. The groups, so variable in form but so rich in colour, of the *Cantharellus cibarius* form attractive objects beneath the overshadowing oaks, while the darker hue and elegant form of the *C. cornucopioides* wins enthusiastic admiration from the naturalist wandering in autumn and early winter among the mossy woods of Herefordshire — it is well named after the cornucopia, which its contour exactly resembles. The rare *Lentinus flabelliformis*, stemless and with fleshy lamellæ, once rewarded my search in Wiltshire, growing round the base of a turnstile post upon the greensand formation. The *Lenzites betulinus*, similar in form, but of a corky texture, is frequent upon stumps of birch in that same neighbourhood; its zones of olive and green and its downy pileus render it an ornament to the otherwise naked stumps. There is a group of Agarics with milky juice; these are very poisonous. I remember blistering my lips with only touching them with the biting juice. Old Gerarde recommends us to confine ourselves to the "Meadow Mushroom" for dietetic purposes, adding, "It is ill trusting any of the rest;" and until our knowledge is more extended, and our observation more on the alert, I think we had better follow his counsel, although we cannot agree with his quotation from Pliny, that "mushrooms grow in showers of raine, *they come of the slime of trees.*"

In the next group to the Agarics we find the hymenium in tubes or pores, more or less broken; hence the group receives the name *Polyporei*. We find Fungi, yellow, brown, white, or tawny; and, upon administering our accustomed kick, we see a spongy under-surface appear, instead of the lamellæ of the Agaric.

These Fungi we call Sap-balls, or *Boleti*. One is edible (*B. edulis*), and of a pale colour; another is very poisonous and dark tinted (*B. luridus*); the apricot-coloured (*B. piperatus*) is peppery; and we cannot recommend the flavour of the gay yellow one (*B. luteus*). In the *Boletus* family the tubes of the hymenium can be separated from one another. Not so in the next family, that of the Polypores. These grow occasionally with stems, as in the *P. varius*, which I found adorning pollard willows on the banks of the Wye; elegant in form, like a scallop-shell, with the hinge prolonged into a stalk, and the pileus shaded richly with umber and crimson; but more frequently they are stemless, growing like shelves and brackets on tree-stumps. Of these the *P. squamosus* is a very handsome member, spreading to the size of from one to two feet, blotched with brown, and forming a remarkable object on the bole of ash-trees. A very firm, woody, fragrant species grows in the form of a bracket on old willows. I have found it in Wiltshire, Herefordshire, and Kent—*P. salicinus*. A minute plant of this family, *P. abietinus*, adorns fir posts, &c. It grows flat at first, and then the edges curl over in the form of frills; the edges and the hymenium are violet, the pileus white and cottony. Some species, as *P. annosus*, grow on the ground; the hymenium white, and the edges, which presently turn up, a full chestnut brown.

Few old stumps in woods or on lawns are quite destitute of the zoned frills of the *Merulius Corium*. The pores here are not equally distributed over the surface, but are arranged in branching lines. In texture it resembles parchment. This plant is brother to the Dry-rot, which so constantly brings ruin in its wake; terrible, less in its perfect state, with fully developed pileus and hymenium, than in its spawn condition, when it eats into wood, rendering it rotten and crumbling, and showing no respect for the most honoured edifice. "It is because the Dry-rot has got in," was the answer returned to my question, why the wall of the curator's house at the Edinburgh Botanic Gardens was taken down; and on putting a similar query to workmen engaged in a Kentish church, I was again told, "The Dry-rot has eaten away both the pews and the flooring." From the perfect plant drops of moisture exude; hence its name, *M. lachrymans*. They might well be tears of repentance shed over its many misdeeds.

The *Fistulina hepatica*, with its shapeless form and blood-red pileus, is found, in the later summer months, growing on trees. It has been recently found in Longleat Park, Wiltshire, and Stoneleigh Park, Warwickshire. In this genus the pores are not only separable, as in *Boletus*, but distinct and tubiform. It forms wholesome food; and I have known persons who have eaten it without bad results, and who describe it as resembling

veal cotelette. All credit to them for their enterprise; for we must own it does not look tempting.

Woods both in Kent and Wilts have furnished me with the pale salmon-coloured *Hydnum*. Here the hymenium is in *spines*, which cluster closely over the under-surface, like miniature stalactites from the roof of a cavern. It forms an excellent dish, being likened to oysters. I have also gathered it in September on the banks of Loch Lomond. Another pretty species, smaller, and shaded with madder, grows on mossy banks in Kent (*H. zonetum*); while many stemless kinds grow as incrustations upon decaying sticks. Upon rotting pales and stumps we see richly-tinted patches, some brilliantly purple, others fine umber brown and velvety; these are *Corticium cæruleum* and *Stereum hirsutum*. In these plants the hymenium is quite *even*, not disposed on lamellæ, or in tubes, or veins, or spines, which feature characterizes the *Auriculini* group.

The *Clavariæ* are among the most attractive of our fungi, carrying their hymenium in the upper part of their branches. Some grow as bunches of yellow coral among the low grass on our downs (*C. fastigiata*); others are equally branched, and snow-white (*C. cristata*), and frequent woods; whilst the amethyst tint of the lilac species favours moorlands. I found it on the heights above Oban.

The last group in the hymenium order is the *Tremellini*. These fungi have the fruit-bearing part mingled with their jelly-like substance. The *Tremella foliosa* resembles a plaited mould of port-wine jelly; the *T. mesenterica*, orange jelly; and the *T. albida* might be a piece of semi-transparent blanc-mange. They grow on dead wood in damp places. The *Exidia glandulosa*, shaped like half a huge black mulberry, and the *Hirneola auricula Judæ*, of ear-like resemblance, both belong to the *Tremellini*; the former growing on dead oak, and the latter on living elder, and lasting through the winter months.

Some years ago a fungus dinner was suggested in the pages of "Chambers's Journal." *Fistulina* was to stand as beefsteak, young Puff-balls for sweetbread, *Lactarius deliciosus* for lamb chops, and *Hydnum* for oysters!

There are also other utilitarian members among our friends. The *Boletus edulis* is much prized on the Continent, and has occasionally been cultivated with success. The *Polyporus fomentarius* forms the *amadou* of commerce, "German tinder" being merely thin slices of the fungus steeped in saltpetre and dried. The Ostyacks use *Polyporus ignarius* as an ingredient in snuff, and the *Pietra funghaia* is merely hard clay penetrated with the mycelium of *P. tuberaster*.

PART II.

"We'll make a feast in our mossy dell,
Of infant Puff-ball and rare Morel,
And many a favoured guest shall sup
On Lily-dew from a siller cup;
The aged Puff-balls shall help us to cheat
The dainty bees of their luscious meat;
While others shall burn to give us light,
And scare from our dell the dreary night."

WICKLIFFE LANE.

THE second family of Fungi in the Spore group is called *Gasteromycetes*, and is characterized by the hymenium being enclosed in a single or double bag.

This family contains a group of subterranean Fungi, one member of which, the *Melanogaster variegatus*, used to be sold in Bath under the name of Red Truffle. Its bag or *peridium* is thin, and the spores are disposed on the summits of cells, in the cavities into which the interior is divided. Nearly allied to these are the *Phalloidei*, well known through the undesirable quality of their representative the Stinkhorn (*Phallus impudicus*), more politely named Wood-witch in some counties. Here the plant is enclosed in a peridium in youth, upon the bursting of which the coarsely cellular column shoots up, bearing as a capital a honeycombed pileus, from which the hymenium exudes in greenish jelly of most offensive odour, which, nevertheless, is greedily devoured by flies. This odour resembles that of putrid animal matter, and I remember hearing the owner of some beautiful grounds lament that some rabbits must be decaying among holes in the rocks, for the smell during the last few days had made the grounds unendurable. He did not lay any blame upon the obelisk-like Fungi growing here and there in the said woods, and the removal of which restored the grounds to their original purity.

The *Clathrus*, another member of this family, is yet more offensive in its odour,—though so gay in colour, being crimson and orange, and branched like coral. It is seldom found except in Devonshire.

The *Geaster*, or Earth-star, belongs to the *Trichogastre* group, characterized by its paper-like peridium. One with a double peridium, *G. fimbriatus*, forms a beautiful object: the outer coat bursts and tears into six or seven pieces, which roll back and lie on the ground in a star shape, while the inner coat opens only at the summit, from whence the dust-like spores

exude. The Common Puff-ball has a double peridium, the outer part peels off and leaves the inner entire. In the young state some Puff-balls make an excellent and wholesome dish, resembling sweetbreads in flavour: in age they delight mischievous boys, who love to puff the powder into each others' eyes, and they perform a beneficent office towards those domestic insects—the bees—who, intoxicated by the fumes of a Puff-ball burnt under the hive, fall down in coma, and the honey may then be taken without the wholesale murder which is too often the cruel reward for their patient industry Our great-great-grandfathers and grandmothers were lighted to evening parties by these Puff-balls, according to Gerarde; and they were also used for tinder by the succeeding generation.

The Edible Puff-ball is *Lycoperdon giganteum;* it also acts as an anæsthetic, according to Berkeley, and may, in future years, be as useful as chloroform.

A number of minute Fungi appearing on rotten wood in autumn and winter, some resembling rusty nails; others, minute pins, their heads bursting and giving forth red or yellow or grey powder; and others, again, beads also dusty in age, succeed the Puff-balls in botanical order, all beautiful and interesting when closely examined. The *Nidulariacei* is the prettiest group in the family *Gasteromycetes.* The peridium is tough and woody, and opens at the top, giving the appearance of a cup the size of a child's thimble, with packets of spores lying at the bottom, attached by an elastic thread, which jerks them out when ripe. The *Cyathus striatus* I found in Somersetshire, growing upon beech-mast; it is hairy on the outside and beautifully striped within. The *C. vernicosus* was the produce of gardens about Edinburgh, where it adorned the box edges with its bell-shaped cups, and is known by the name Siller Cup; and the smaller species, *Crucibulum vulgare,* was contributed from stubble fields in Shropshire.

The third family of the Spore class is characterized by the whole mass being formed of dust, sometimes enclosed in a cover, sometimes naked; it is called *Coniomycetes.* The Fungi of this class are chiefly parasites and epiphytes, growing as specks and blotches—white, orange, brown, red, or black—on dead twigs and leaves. One of this family, the *Tilletia caries,* attacks the grains of wheat, which it turns black, and it gives them an offensive odour; flour made from the infected grain can only be used for gingerbread, as the condiments combined with it disguise the smell. The *Ustilago segetum,* another member of this family, attacks all cereals. The Red Cheese Mould belongs to the *Coniomycetes,* and has a fairer reputation.

The *Hyphomycetes,* or Thread Fungi, constitute the fourth

family; they form beautiful objects under the microscope, but present merely black or coloured blotches to the naked eye. The Blue Mould of cheese is a popular member of this family; and the Potato Blight (*Peronospora Destructor*) is the most detested. It seems to spread through the whole plant, stem, leaves, and tubers. It consumes the starch, filling up the cells with its poisonous spawn. The mould familiar to us on jams, etc., is nearly allied to this. The spores of these plants are of amazing lightness, and float in the air in myriads, germinating when they find a suitable matrix. The Vinegar Plant has numerous barren threads which grow into a tangled mass. The Yeast Plant belongs to this group. Arising, like other Fungi, from spawn in the first instance, yet its spores multiply with such exceeding rapidity that it does not depend on the spawn for propagation: a simple cell placed in a congenial position buds in the course of an hour, and thus chains of cells are formed. These dried constitute the "German yeast." Hogg informs us that ringworm and another allied diseases are produced by a plant of this order; he also appears to be of opinion that such microscopic Fungi had a share in causing the cholera, great quantities having been detected in the air at the time when it raged. The mildew, so destructive to silk, gloves, etc., is of this group; another is found eating into the glass of our mirrors; and there is even one species which infests the chemical solution used in electrotyping. Some members of this group are able to bear any climate, from the heat of the Tropics to the cold of the Poles.

In the SPORIDIFEROUS group there are but two great families. The first, *Ascomycetes*, is characterised by the important distinction of the spores being enclosed in bags, or *asci;* the second, *Physomycetes*, are merely moulds.

Many members of the first group, the *Evellacei*, equal in stature and interest the aristocratic Agarics. The *Morchella esculenta*, or common morel, is much prized in Yorkshire, as giving excellent flavour to gravies, and no good housekeeper is without a string of them suspended in her store-room. Here the hymenium is in honeycomb cells on the upper surface of the cone; the stem is white and the head brown; they are found on field borders in May and June. So highly did the Germans appreciate its excellence, that they used to burn down a portion of forest every year, because the wood ashes secured a crop of morel; this custom was stopped by an edict of state. The *Helvellæ* have an even hymenium, drooping over the stem; there is an edible species, but I do not know its recommendations.

The *Mitrula paludosa*, with its white stem as thick as a goose-quill, and its orange club-shaped head, is a pretty orna-

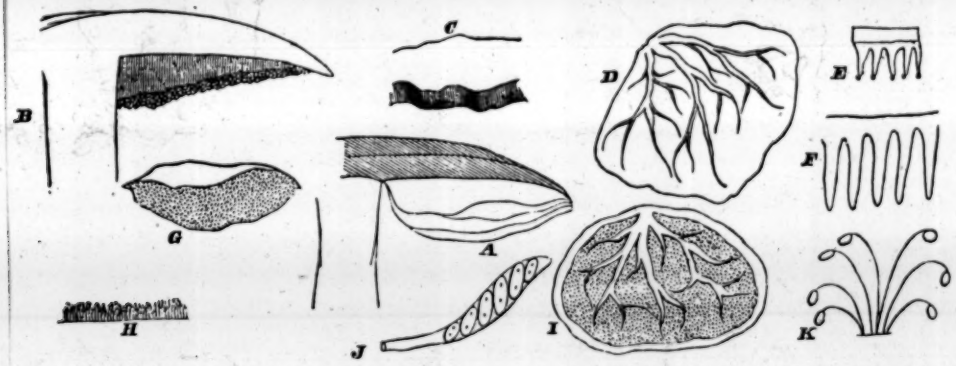
ment of peat-bogs in Yorkshire, while the *Leotia lubrica*, of similar form and olive colour, graces the Kentish hedgerows. But of all the wicked-looking Fungi, none have so weird an appearance as the black *Geoglossum*. It is well termed Earth-tongue, for it springs in a tongue shape from the ground, black and glutinous. I have seen it in cultivated plantations in Wilts, in woods in Herefordshire, and abundantly among the sward of Scottish heaths all about the Western Highlands. Contrasting agreeably with this, come the troop of brilliantly-coloured *Peziz*æ. Here the hymenium is *within* a cup—or sometimes saucer-shaped disk. The irregular cups of the large orange species (*P. aurantia*) grow in gardens and plantations in most counties. I have often seen them in Kent, and I remember them also in the cemetery at Glasgow. Many of the cups were as large as half a hen's egg, bright orange within and paler without. A round species, rough on the exterior and brown within and without, quite globular in youth and never fully expanding, is frequent in hotbeds; it is the *P. vesiculosa*. But the favourite of the family is the *P. coccinea*, adorning dead twigs of hazel with its scarlet cups, and forming with moss a charming winter bouquet. Children call it Fairy Bath. There are a great number of these *Peziz*æ, some larger even than the *Aurantia*, though not so brilliant in hue; and others smaller and yet more minute, till they become microscopic objects—lemon, white, blue, crimson, and green. The spawn of one of the latter colour imbues the wood on which it grows, and makes it very valuable for the workers in Tunbridge ware; it is the Verdigris Peziza.

The *Truffles* are members of this Ascomycetes class. The asci fill the inside of the plant, with the exception of branching partitions. They are subterranean in their habitat, and can only be found by means of a trained dog, who traces them by their powerful perfume.* They are famous in the annals of gastronomy, and Perigord pie owes much of its excellence to them. Under beech trees is their favourite position, and they are to be found in many districts of the South of England. Many species are sold in the Italian markets; one, with a garlic flavour, obtains as high a price as 9s. per pound.

The *Sphæriacei* are a very large group in this class, but most of them are microscopic objects. The *Cordiceps militaris* is one of the prettiest members. It has a distinct stem, and its head is club-shaped. Of the same genus is the *C. purpurea*—the famous Ergot, so deadly in its effects. It attacks all cereals, but more especially rye. Flour made of ergotted rye is so

* See "Popular Science Review," No. IV. (Vol. I.), page 496, "The Common Truffle (*Tuber cibarium*), by Jabez Hogg, F.L.S., &c." (illustrated).

unwholesome that when in a time of famine some Norman peasants lived upon it, they were attacked with a very horrible form of gangrene, and died in great numbers. In the history of the faculty this poison is turned to good purposes, a valuable and potent medicine being extracted therefrom. It is likely that from this plant, or one of its allies, the famous Gipsy poison, the *drei*, is concocted. The Candle-snuff Fungus (*Xylaria hypoxilon*) is one of this group; its burnt-looking stems, crowned with white powder in youth, and afterwards swollen with the full asci, are familiar to us about tree stumps, etc. A few epiphytes, among which are the Hop, Rose, and Vine Mildews; a curious genus of minute Fungi infecting rotting horse-hoofs and cloth; and a series of true Moulds, as the Bread, Dung, and other Moulds, complete the group called *Hyphomycetes*, and conclude the list of British Fungi.



A. Agaric; B. Boletus; C. Polyporus; D. Merulius; E. Fistulina (*magnified*); F. Hydnum (*magnified*); G. Stereum; H. Hymenochæte; I. Tuber; J. Ascus; K. Jam Mould (*magnified*).

EXPLANATION OF PLATE XV.

HYMENOMYCETES.

Fig. 1.	Amanita muscarius	Agarics, with hymenium disposed in lamellæ	Crimson.
Fig. 2.	Lepiota rachodes		Brown & white
Fig. 3.	Psalliota campestris		
Fig. 4.	Cantharellus cibarius	Hymenium in veins	Orange.
Fig. 5.	C. cornucopioides		Dark brown.
Fig. 6.	Boletus luteus	Hymenium in pores	Yellow.
Fig. 7.	Merulius corium	Hymenium among veins	Shaded brown.
Fig. 8.	Clavaria fastigiata	Hymenium in the clubs	Yellow.
Fig. 10.	Tremella alba	Hymenium in the gelatinous substances	White.
Fig. 13.	Exidia glandulosa		Dark purple.

GASTEROMYCETES.

Fig. 12.	Cyathus striatus	Hymenium enclosed in a double or single envelope	Light brown.
Fig. 14.	Phallus impudicus		
Fig. 15.	Geaster fimbriatus		Light brown.

ASCOMYCETES.

Fig. 9.	Geoglossum viscosum	Asci in clubs	Black.
Fig. 11.	Mitrula paludosa	Asci in the cup	Orange.
Fig. 16.	Peziza aurantia	Asci within the cup	Orange.
Fig. 17.	P. coccinea		Scarlet.
Fig. 18.	P. versiformis		Green.
Fig. 19.	Xylaria hypoxilon	Asci in the branches	Black.

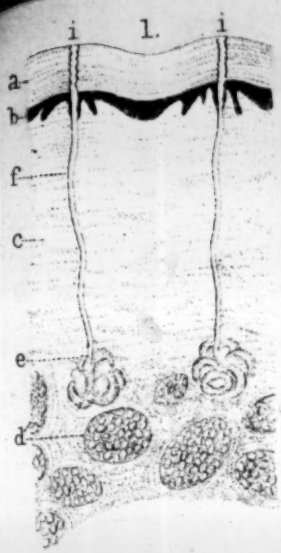
THE SKIN.

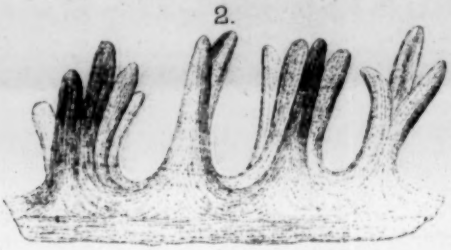
BY ISAAC ASHE, M.B., CH. M.

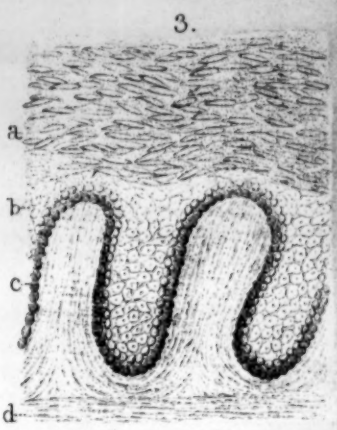
IT is a characteristic difference between the works of man and the works of the Creator that the former has to adopt many contrivances, and employ a cumbrous machinery, to bring about a single result, whereas the Creator generally accomplishes several ends by one and the same agent; and in few organs of the body, or in none, perhaps, is this more manifest, than in that one of which we are about to present to our readers a brief sketch.

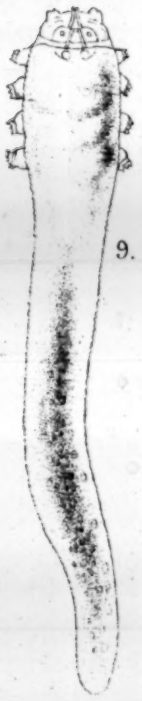
We little think when we look at the Skin of our bodies, apparently so simple, what a wonderfully complex structure it really possesses, or how numerous, how varied and important, are the uses it serves in our animal economy.

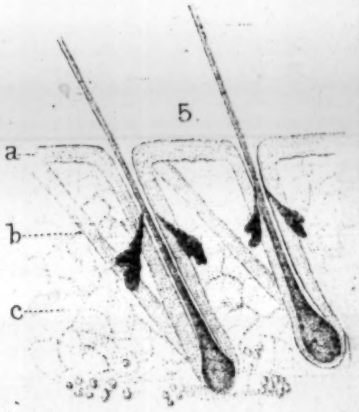
Our readers would, perhaps, be startled to hear that our stomach, our liver, nay, even our brain itself, are less necessary to life than our skin. Yet it is well known that we may do without food, live without calling our stomach into action, for several days; that the liver also may wholly cease to act for several days before death ensues; and it has also been known that several monsters have been born without any brain whatever, which yet have survived for several days, discharging all the functions of organic life,—exercising motion, sucking at the breast like other infants, digesting their food, &c.,—and have continued so to do for a number of days greater than the number of hours it would be possible to survive were the functions of the skin completely stopped. The experiment has actually been made on the lower animals, and the results show that the skin is a most important auxiliary to the lungs in the process of aëration of the blood; and that if its functions be arrested, as has been done by varnishing the fur in a rabbit, or gilding the skin in a pig, the unfortunate animal dies in a couple of hours or so, with all the symptoms which would be produced by a slow cutting off of the supply of air to the lungs. On one occasion, before this fact was known, the experiment was unfortunately performed on a child, and with a like fatal result. This was on the occasion of the accession of Leo the Tenth to the Papal chair, when he gilded a child all over at Florence to represent the Golden Age; but the unfortunate child died in a few hours very unexpectedly, representing, we suppose, the short

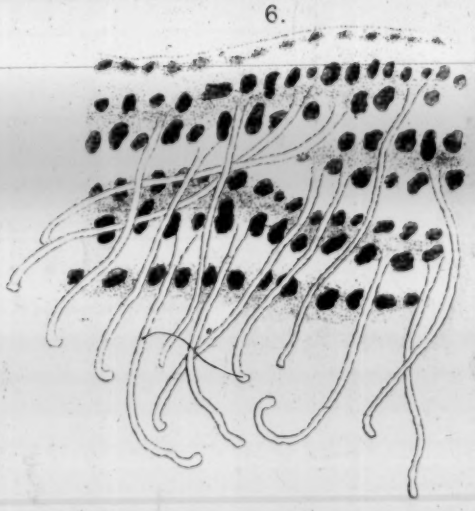












E.R.Lankester, del.

W. West, Lith.

Anatomy of the Human Skin.

duration of the age in question, and causing no little astonishment and speculation among philosophers, and probably no less superstitious feeling in the minds of the vulgar.

From these experiments we can easily infer how important a matter it must be to keep this organ constantly in an efficient state for the discharge of this as well as its other important functions. Indeed, this one organ the Creator has put specially into our charge, while all the other organs of our body are beyond our control. Yet often when we have neglected this charge, and suffer in consequence, we lay the blame upon organs wholly guiltless of our sufferings, such as the liver or stomach, which will work perfectly right without our care or attention, if we only give them fair play, and do not, by our neglect of the skin, throw upon them an amount of work twice as great as their proper share.

In insects, the entire respiration is conducted by means of pores in the skin, to which the name of *spiràcles* is given, and of internal tubes called *tracheæ*, and they possess neither lungs nor gills. Hence arises the difficulty of drowning an insect in water; for as the pores are guarded by minute hairs, the water cannot enter them: but if a feather dipped in oil be applied to the abdominal portion of an insect's body, as to the yellow part of a wasp, it falls dead immediately; being, in fact, suffocated by the oil, which readily enters the pores in spite of the hairs, and so stops the respiration.

Aëration of the blood is not, however, the only function which the skin has to discharge; absorption is another, though not of equal importance. This is carried on by a system of vessels called the lymphatic vessels, which permeate the skin everywhere over the whole surface of the body. To illustrate this function, we may mention the fact, that persons in whom disease has closed up the natural entrance to the stomach by the throat have been kept alive for days and weeks by being frequently immersed in a warm milk bath. The late celebrated Duc de Pasquier, who died a short time ago at the age of ninety, had been kept alive for some weeks before his death by this means. Various salts, also, have been detected in the secretions of persons who have used baths containing those salts in solution, such salts having been taken up by the skin. Persons in distress for want of water at sea have also sometimes relieved their thirst by bathing the body in sea-water, so rapidly is absorption carried on under such circumstances.

Another and a most important function of the skin it discharges as the organ of the special sense of touch, which is only a highly exalted form of general sensation, which also resides specially in the skin. Under certain circumstances the reference of sensation to the part of the body touched becomes

perverted; as in the case of a limb which has been removed, where, when the nerves that supplied the removed part are affected with pain, this is referred to the part which has been lost, it may be, years before.

The functions of the skin as a covering for the body, adding beauty and preserving the delicate structures underneath, regulating the intensity of sensations from without, and (by a beautiful contrivance which we shall subsequently refer to) the amount of temperature within, are a further illustration of the multiplicity of ends attained by the Creator through one and the same agency; and, though last, not least, we may mention the function of excretion, or removing from the body materials no longer of use to it, and which, if retained any longer, would become actually injurious to it.

We shall now proceed to describe the beautiful structure of the skin, by which it is adapted for the discharge of these numerous and important offices. The skin is composed, as most of our readers are aware, of two layers; an outer, called the *cuticle*, or scarf-skin, or sometimes termed the *epidermis*; and an inner, called the *cutis*, or true skin, or sometimes the *dermis*. This latter rests upon a very fine interlaced or netted structure, called the *areolar tissue*, out of which, if we may so express it, the granules and fibres of the skin are formed.

It has been usual to describe a third layer placed between the true skin and the scarf-skin, and called the *rete mucosum*, or pigment layer; but later researches have shown that there is no such distinct layer, and that the pigment cells, to which the colour of the skin in different races is due, are but a different stage in the development of the scarf-skin. This scarf-skin is never of very great thickness in any animal, but the true skin is of very variable thickness, and is that portion of the skin on which depends the thickness of the hide of the pachydermatous animals, a character so remarkable as to give name to the class to which they belong, which includes such animals as the rhinoceros, hippopotamus, elephant, horse, pig, etc. In the whale the cutis attains the thickness of about an inch, which is the greatest known in any animal.

It seems the most natural method in describing the skin to begin with the cuticle, which is at the surface, and so proceed from the better known to the less known, as in most other matters of knowledge. The cuticle, then, consists of several layers of laminated scales, the laminated form being best marked at the very surface, where the scales are constantly falling off as a kind of scurf, and are as constantly being renewed from below. These scales are formed by the flattening out of granules more or less rounded, which is the form assumed by the particles of the cuticle in its deeper layers; these granules

are at first nucleated cells, and the colouring matter of the skin resides in the nuclei, and these granules it was that were formerly described as a separate layer under the name of the *rete mucosum*. They are very minute, being about 1-3000th of an inch in diameter at first; being renewed from below as the flattened scales are removed above, they gradually approach the surface, and as they do so they more and more lose the granular form and assume the scaly character, their diameter increasing accordingly to about 1-600th of an inch. In many animals, however, they are much larger than this, for the scales of reptiles and fish are indeed only a modified form of these epidermal scales in man; and in some of these creatures, as serpents, the epidermis, instead of being in a constant state of renewal and repair, as in man, is only removed at one particular season, when it comes off *en masse*, and is called the *slough* of the reptile. As may be supposed, the body of the animal is very tender after this process, and it goes off and hides itself for a season, until nature has repaired the loss of the old epidermis by a new one. Something similar to the gradual hardening of its new skin which then takes place we see in ourselves in the gradual hardening and thickening of a new nail, if we accidentally lose one, which we may observe to grow in thickness as well as in length. In fact, the nails are nothing more or less than modified cuticle placed in the position we find them in order to give protection and support to the ends of the fingers, and so enable the tips of the fingers, which are the tactile organs in man, duly to appreciate the nature of the bodies with which they come in contact; and it is found that the tactile sensibility of the finger is much impaired by the loss of the nail. In some of the lower animals the nails are further modified into claws, so as to become weapons of defence and offence.

Into the epidermis or cuticle no nerves or blood-vessels penetrate, and it is nourished merely by the transudation of the serum of the blood through the walls of the vessels of the true skin and subcutaneous areolar tissue; and as it has no nerves it is not itself sensitive, but on the contrary, serves to blunt the too exquisite sensation of the true skin. That it has no sensibility of its own may be proved when a small portion of it is detached from the underlying surface of the true skin, as by a blister; and this is the best way of demonstrating the cuticle in a living person, as it is extremely difficult to detach any portion of it by mechanical means.

Next we come to the structure of the cutis, or true skin, which is much more highly organized, and consists of two kinds of tissue, namely, white and yellow fibres; the former being denser and more resisting, and being therefore present

in greater quantity wherever resistance is most needed, as in the palm of the hand and sole of the foot; while the yellow fibres are a highly elastic tissue, owing to their minute fibrillæ being arranged in interlacing curves, and these fibres cross each other repeatedly, and branch so as to form minute lozenge-shaped interstices, which are filled up principally by the white fibres. These yellow fibres, accordingly, as might be anticipated, exist in greater abundance where elasticity is a special requirement, as at the flexures of the joints, the lips, etc.

The uppermost surface of the cutis or true skin is strangely uneven and irregular, being elevated into a vast number of minute papillæ, which are about 1-100th of an inch in length, and 1-250th of an inch in diameter. Minute as these little papillæ are, each possesses a ramification of vascular capillaries and of nerve fibres; the latter, though not traceable to the very surface—being in fact the essential agents in the sense of touch, for that is the function of these papillæ,—they are the seat of the tactile power, and accordingly we find them developed in the greatest number and perfection where the tactile power is highest, as along the tips of the fingers and the lips in man, the lips specially in many quadrupeds, as the horse—these organs being the principal seats of the tactile power in them; also along the membranous expansion of the wings in bats, where the sense of touch and appreciation of impact are so delicate that the animal, even though blinded, can fly between suspended threads without touching them. These papillæ are also very well developed on the trunk of the elephant, the snout of the tapir, and at the roots of the hairs of the whiskers in the feline tribe, as well as on the under-surface of the prehensile tails of some of the monkey tribe, where the sense of touch is so delicate that they can ascertain by clasping it in their tails whether a nut has a sound kernel or not, and so save themselves a useless trouble and disappointment in cracking it if unsound. These papillæ are quite distinguishable on looking at the hand, for their extremities are received into depressions on the under-surface of the scarf-skin, and when this is stripped off and examined with a low power these pits or depressions are well seen, arranged in single or double rows, which correspond with the papillæ beneath, and above with the grooves or furrows which are visible on looking at the palm of the hand and inner surface of the fingers. These furrows are caused by the scarf-skin dipping in between the rows of papillæ, and all along each furrow at very minute intervals may be seen little cross lines which indicate the separations of the individual papillæ, or rather pairs of papillæ, for they are usually arranged in pairs. The number of these papillæ is immense; a square inch of the palm of the hand will

contain more than forty rows, and each row more than sixty pairs, making in all about 5,000 individual papillæ in a single square inch of skin. They are not, however, equally well developed in all parts of the body, being nearly absent on the back, where, however, the cutis is tolerably dense, for there is no relation between its thickness and the development of these papillæ; on the tongue, for instance, the cutis is extremely thin, and yet the papillæ there are larger than in any other part of the body, and not that alone, but so thin also is the cuticle here that the individual papillæ are seen, giving that peculiar roughness to the tongue which is found to a certain degree in man, and to a very high degree in some of the lower animals, as the ox and the cat tribe.

Professor E. H. Weber instituted some delicate experiments on the sense of touch with the view of ascertaining its relative delicacy in different parts of the body, the method he adopted being to ascertain at what distance from each other two points of contact ceased to be perceived as one only, and were distinctly recognised as two. For this purpose he slightly blunted the points of a pair of compasses with sealing-wax and then applied them to different parts of the body. He then found that on the pulp or soft part of the tip of the fingers the points were perceived as two when separated only 1-36th part of an inch, while on the middle of the arm and thigh they had to be separated as much as 2½ inches. He also found, as might be expected, that they were more readily perceived as two when placed across the direction of the branches of the nerves than when placed parallel to their branches. A well-known fact is that the sensations of heat and cold, which of course appertain to the sense of touch, are to a certain degree relative; that is to say, that if we place one hand in warm water and the other in cold, and then plunge both into a vessel containing water at an intermediate temperature, this will appear hot to the hand which has been in the cold water and cold to the other. Weber has also shown a very curious fact, namely, that if both hands are plunged into water of the same temperature without previous preparation it will seem warmer to the left hand than to the right. To obtain an accurate result this experiment ought to be performed with the eyes blinded, and in ignorance of the relative temperature of the water in the two vessels, so as to remove the influence of reason or imagination. Some other curious phenomena regarding the sense of touch have also been found to exist, such as that if two of the fingers be crossed and then a single small object, as a pea, be placed between them, the mind will appreciate it as two objects; or, again, that if two points, as of a pair of compasses, be applied to the skin at a fixed distance, they will feel as if

more widely separated when on a very sensitive part than they will elsewhere, or if drawn along the skin from a less to a more sensitive part will seem to separate as they approach the latter; and, again, that a perfectly plane or level surface may be made to appear concave by another person drawing it over the tip of the finger of one whose eyes are covered, and pressing at first strongly, then lightly, and then strongly again, or it may be made to appear convex by reversing this order of pressure; but if the pressure is regulated by the subject of the experiment himself the delusion vanishes. Indeed, all these experiments ought to be performed on a person whose eyes are blinded, and by a second party.

The extreme delicacy to which the sense of touch may be brought by practice often receives curious illustrations. One of the best known is the ability of the blind to read raised letters; and in one case, when the sense of touch of the pulp of the fingers had been much reduced by injury, the sufferer learned to read by applying her lips to the letters. It is said that in counting rapidly a roll of bank-notes, a clerk in the Bank of England will be able to detect a counterfeit note by the touch alone, which no examination by an ordinary individual could distinguish from a genuine note, even were he aware that it was forged.

Such are some of the wonders of the sense of touch,—a sense whose impressions are conveyed to the mind by nerves set apart for that office, these nerves being the posterior roots of the spinal nerves, and the fifth and eighth cranial nerves. The fifth cranial is, indeed, a very singular nerve; for, besides having motor fibres as well as sensitive, it has some of its sensitive fibres so modified, that in the papillæ of the tongue they become the nerves of the special sense of taste; and indeed, in some of the invertebrate animals, as the crustaceans, this nerve also receives the impressions of the special senses of sight and hearing.

We come now to the function of secretion, and the description of the beautiful and complex apparatus by which that function is carried on. When we look with a simple lens, or even with the naked eye, at the delicate grooves crossing the furrows of the hand above mentioned, we find that a small orifice exists in the centre of each of them, sometimes occupying nearly the whole of the groove. This is, in fact, the orifice of a perspiratory duct; and when the hand is warm the perspiration may be observed, even with the naked eye, to issue from it, forming minute shining dots. The glands by which the perspiration is secreted are seated at the under-surface of the true skin, each embedded in a cavity in it; and they consist, like many other glands, of a ravelled tube formed of basement membrane and epithelial scales, together with true secreting structure; the materials for secretion being

furnished by a minute capillary network of blood-vessels arising from arterial trunks, which bring the blood to the gland to be purified, and terminating in venous trunks, which carry off the blood when that process has been performed.

These glands are consequently to be regarded as true excretory organs, removing from the blood materials that are no longer wanted, and which, if retained, would be injurious. Their size varies in different situations, being in the palm of the hand from 1-100th to 1-200th of an inch in diameter, but in the arm-pits, where they are largest, and form a very thick layer, they reach the size of 1-60th of an inch. Their ducts are composed of basement membrane and epithelium only; the latter being an inflection from the scarf skin which runs down the wall of the duct. The length of the tube which constitutes both gland and duct is about a quarter of an inch. It is straight while passing through the true skin; but becomes strongly spiral while traversing the scarf-skin, the turns being as close and regular as those of a screw. The diameter of this tube is about 1-1700th of an inch. We can have little idea of the importance of these little ducts to the system from considering any single one of them; but when we come to consider them collectively, we may in some degree estimate their value, and the necessity of maintaining their functions in healthy action. Over 3,500 of these little ducts have been found to exist in a single square inch of the skin of the palm; and accordingly, taking the length of each at a quarter of an inch, as we mentioned above, we find that their aggregate length amounts to 73 feet. On a square inch of the heel the length would be about 47 feet. About 60 feet would represent the average length of these ducts for a single square inch of skin for the whole body; and as the number of square inches in a person of ordinary size is about 2,500, we arrive by computation at the startling result, that the aggregate length of the sudoriferous ducts of the body is about 28 miles.

It was to this glandular system we referred, when we said there was a beautiful contrivance for regulating the internal temperature of the body; for the perspiration so poured out is vaporised principally by the heat of the body; and in thus turning into vapour it renders latent, as all liquids do in undergoing that change, an enormous amount of heat, which is thus being constantly carried away from the body as fast as it is generated by the chemical processes constantly going on within the system. Hence we see the cause of that burning heat of skin which is so marked a symptom of some diseases when the perspiration is completely arrested, causing that peculiar harsh, dry skin, which is so well known to the physician as the concomitant of this burning heat.

It is due to the same cause that the blood never exceeds about

98° Fahr. in temperature, even under violent exercise; for a copious flow of perspiration carries off the heat so generated. And for the same reason it is possible in dry air to bear with impunity a degree of heat much beyond what could be borne in moist air, where the perspiration would not be vaporised as fast as excreted. Water, at the temperature of 120° is almost unbearable. A vapour bath at the same temperature might be endured for a few minutes; but the distress arising from the suppressed perspiration would soon render it intolerable. But in dry air a heat can be borne with impunity, and almost without discomfort, which will roast eggs and dress beafsteaks. In some experiments performed by Drs. Watson and Carpenter, it became desirable to ascertain the height at which a thermometer stood in an oven, without subjecting it to the cooling consequent on withdrawing it. A girl volunteered to go into the oven and mark the height of the mercury. The gentlemen hesitated at her proposal; but she assured them she was not in the least afraid of so doing; and she actually went in, and remained there for ten minutes, while the thermometer stood at 280°; and another girl remained for five minutes in the oven with the thermometer at 325°, or 113° above the point of boiling water. Beefsteaks were cooked in this oven, merely by the temperature of the air, in thirty-three minutes; and when the air was blown on them by a pair of bellows, they were cooked in thirteen minutes. And yet in these experiments the young women suffered scarcely any inconvenience; and the heat of the body, as tried by a thermometer placed under the tongue, was scarcely at all increased. Sir Charles Blagden remained for some minutes in air of about the same temperature, and also Dr. Lankester; and Chabert, the French showman, called the Fire King, was in the habit of entering an oven heated from 400° to 600°, or within a few degrees of the heat of molten lead. Animals covered with hair or feathers, however, die very soon in temperatures much below these; apparently because the hair or feathers interfere with the free escape of moisture from the skin, which is necessary to keep the blood cool, and prevent injurious consequences. Hence, also, persons who are in the habit of taking Turkish baths, which are, in fact, hot-air baths, experience no inconvenience from the high temperature as soon as the perspiration begins to flow, which, in a practised bather, it does immediately.

The amount of liquid which, in a person in health, issues from the pores during the twenty-four hours is not less than an imperial pint, containing about an ounce of solid matter in solution, and besides a large amount of carbonic acid gas: hence we can estimate the importance of keeping these ducts in perfect order by means of frequent bathing.

Another kind of gland is also found in the skin in connection with the hairs, and engaged in their nutrition. These glands are called the sebaceous glands, inasmuch as they furnish an oily or waxy substance to nourish the hairs; this substance is developed in largest quantity inside the ear, where it serves to prevent access of dust, insects, &c., to that delicate organ. The ducts of these glands are not spiral, and they open generally into the hair follicles, or pits which the hair grows out of, situated in the subcutaneous areolar tissue.

There are generally several glands connected with each hair; their ducts are frequently inhabited by a very peculiar little parasite, by no means a beautiful object when viewed under the microscope, but found even in the cleanest and healthiest persons, sometimes three or four being in each follicle; yet they are specially found in persons whose skin is torpid in its action, and they multiply in sickness. These glands lubricate the skin, and so maintain its elasticity, and they also serve to eliminate hydrocarbons from the system; they are extremely numerous, as may be inferred from their connection with the hairs.

We may here mention briefly the structure of hair, as being connected with these follicles. Hair may be regarded as a kind of modified cuticle, though it takes its origin much deeper than the cuticle, and even deeper than the true skin. The scales of the epidermis descend into the hair follicle, forming its lining, and then, at the bottom of the follicle, the cells which on the surface would become cuticular scales are changed into a layer of imbricated or overlapping scales, which form the cortex or bark of the hair; while the cells which grow from the very bottom of the follicle are modified into elongated fibres, and so form the inner substance of the hair.

A very curious and beautiful structure is especially developed around the hair follicles and sebiparous glands, consisting of minute, quite microscopical muscular fibres, not capable of being acted on by the will, but acting involuntarily on the application of certain stimulants, external or mental; cold, fear, anger, &c., will stimulate these fibres to contraction, and hence, owing to their peculiar interlacing around the hair follicles, arises the peculiar bristling so well seen in some animals, particularly the lion and others of the cat tribe, under the influence of these emotions. To this cause also is due what is known as the hair standing on end, the first notice of which we have in the Book of Job—"Then a spirit passed before my face; the hair of my flesh stood up." The creeping of the flesh under the same emotions is due to the same cause; for, although particularly well developed around the hair follicles, these muscular fibres are not confined to them, but extend everywhere through the skin, and the appearance assumed by the skin under the in-

fluence of cold, and known as the "goose-skin," is due also to their contraction.

Hair is almost universally the covering of the skin in the class of Mammalia, and is found even in the whale, but only in the shape of a few scattered hairs here and there over the body, so that it can be of no use except to carry out the type of the organisation of the class. In certain parts of the bodies of some animals hairs sometimes become remarkably developed and strangely modified, as is the case in the hedgehog and porcupine, where they assume over the greater part, but not the whole of the body, the form of spines and quills.

In the class of birds hair is not found, being replaced by feathers, and the apparent hairs on animals of this class, on being examined with a microscope, present the characters of feathers, and not those of hair.

We have thus sketched the principal characters of that beautiful organ, the Skin, which, it is hardly necessary to observe, is as completely illustrative of the Creator's skill and wisdom as is every other portion of the animal frame.

EXPLANATION OF PLATE XVI.

Fig. 1. Vertical section through skin of thumb.
a. Horny layer of epidermis; *b*, its mucous layer; *c*, the corium; *d*, fat globules; *e*, sudoriparous glands; *f*, their canals; *i*, sweat-pores.

Fig. 2. Compound papillæ, from the hand.

Fig. 3. Section through the skin, from the leg of a negro; *a*, horny layer of epidermis; *b*, mucous layer; *c*, coloured cells of the mucous layer; *d*, papillæ.

Fig. 4. Termination of a nerve in a Pacinian corpuscle, from the hand; A, nerve; B, envelope.

Fig. 5. Perpendicular section through the scalp, with two hair-sacs; *a*, epidermis; *b*, muscle of the hair-follicle; *c*, cutis.

Fig. 6. Under-surface of the epidermis, from the palm, showing the depressions in which the papillæ were lodged, and the sudoriparous ducts attached.

Fig. 7. Section through the skin, near the ear. *a*, horny layer of epidermis; *b*, sebaceous glands; *c*, canal of; *f*, ceruminous glands; *d*, hair follicle; *g*, fat globules.

Fig. 8. Hair-sac, from the face, with several specimens of *Demodex folliculorum* attached.

Figs. 9, 10. *Demodex folliculorum.*

Figs. 1—7 are after Kolliker (Hum. Hist.)
Figs. 8—10. E. Wilson, in Proceedings of Royal Society.

THE FURNITURE WOODS OF COMMERCE.

BY P. L. SIMMONDS.

THE commerce in Foreign Woods carried on by this country is much larger than would be supposed by those who had not looked into the figures; and the vast quantities of timber, useful and ornamental, received, form a very interesting subject of inquiry. The timber of many countries is a most important item in its annual income, especially in Russia, Austria, Norway, Switzerland, Brazil, and also in British North America, India, Guiana, and some other of our possessions. The value of the woods of all kinds that we import is not less than twelve millions sterling, whilst about four millions more may be set down as the value of the home produce. These woods, as far as their economic uses are concerned, are divided into three classes:—

1st.—Woods of construction, useful for ship and house building and other rough work.

2ndly.—Those suitable for cabinet and ornamental work, as tables and other articles of furniture, pianofortes, &c.

3rdly.—Dye-woods, and many hard woods, used chiefly by the turner, carver, engraver, &c.

To the first class belong such woods as the fir, and indeed all the Coniferæ, if we except the evergreen cypress, whose beautiful colour and pleasing odour fit it in an especial manner to rank among the higher class of cabinet woods. To this division belong also the beech, ash, chestnut, poplar, and willow; while teak, oak, and plane-tree would seem to occupy a middle class, connecting this with the second, or more ornamental woods, among which are ranked mahogany, rosewood, walnut, maple, laburnum, mountain ash, box, &c.

It is to the Furniture Woods that we purpose confining our present observations, and chiefly to those received from foreign countries.

The importance of this survey will be better appreciated when it is stated that the annual value of the household furniture made in this country alone was, more than ten years ago, estimated at fifteen millions, and has certainly largely increased since then, keeping pace with the wealth and numerous wants of the nation, and progress of commerce. The computed value of the rough fancy hard woods imported in 1861 was £804,426,

to which has to be added household furniture and cabinet-ware, valued by the importers at £32,557; 769 pianofortes, of the declared value of £24,542; besides other items. This, then, forms the aggregate trade in which we are specially interested, quite exclusive of the large commercial trade in rough woods and furniture carried on by other European nations.

The foreign fancy and hard woods specifically enumerated in the official trade returns are very few, being only mahogany, rosewood, maple, satin, walnut, ebony, and cedar, besides a few such as box, barwood and camwood, brazilleto, &c., which are chiefly used for other purposes. There are, however, some very beautiful woods which, being scarce, are imported in but small quantities.

Oak, ash, elm, beech, birch, &c., are designated *hard woods*; whilst mahogany, rosewood, zebra, tulip, kingwood, satin, and other furniture woods, are usually sold under the denomination of *fancy woods*. From the most common description of pine to the finest variety of satin-wood or calamander, from mahogany to walnut, from wainscot to ebony—all are in some way or other made to do service in their respective places for the cabinet-maker.

The elements of beauty in wood may be considered as consisting in lustre, figure, and colour; in the degree of which there are, however, numerous modifications as well as limitations.

The medullary plates contribute essentially to the character of ornamental woods, not only from being the secondary cause of the lustre of most of those woods that are remarkable for this quality, but likewise by their own inherent properties. In nearly all the coloured woods the colour of the medullary plates is much deeper than that of the fibres, sometimes varying even in kind, so that when viewed in different lights they present different colours. The plane or sycamore is remarkable for the size and distinctness of its medullary plates, these being of a rich chestnut brown, with a considerable lustre, while the fibres are nearly white and almost dull.

There is another source of variety in wood, both in figure and colour, depending on the comparison and contrast of one annual layer with another. Much irregularity takes place in this respect. But this very irregularity is a source of beauty, and is capable of being indefinitely varied by making the section more or less oblique to the axis of the tree. An alternation of colour not unfrequently accompanies these concentric rings, but is not indicative of any change of structure; and when the colours are lively, well defined, and well contrasted, their effect is very agreeable: kingwood, tulip-wood, Amboyna wood, yew, lignum vitæ, and partridge-wood, are perhaps some of the most remarkable.

This symmetrical distribution of colour passes by insensible degrees into the striped, the veined, and the mottled, of which walnut affords the best example among the more common woods; and spotted and veined ebony, rosewood, zebra wood, and Coromandel wood, among the more valuable ones. The three latter are particularly beautiful, especially the Coromandel wood, whether we regard the harmonious tone of its colours, passing from brownish white to rich chocolate, or nearly black, or the broad masses in which these are arranged, giving it more the appearance of brecciated marble than of wood.

One other variety in the figure of woods is the occurrence of eyes, zoned spots and small curls, of which the bird's-eye maple, amboyna wood, and the root or burr of the yew and the common maple are the most beautiful. The knobby tubercles that form on the root and trunk of the common elm, from repeatedly stripping off the side branches, afford a very beautiful wood called "curled elm."

We will pass on now to notice the principal woods, giving prominence to Mahogany as being that most largely used.

In 1820, when the duty on mahogany was £11 17s. 6d. the ton, the imports were 16,005 tons; in 1830 nearly the same, although the duty had been reduced in 1826 to £7 the ton. In 1850 the imports were 33,650 tons; and in 1861, 53,108 tons, valued at £569,000. Mahogany unquestionably occupies the highest rank in the scale of furniture woods; it has long continued in steadily increasing request for all kinds of cabinet work, ornaments in wood, and generally for all purposes to which timber is applied for interior decoration. A thousand pounds has frequently been given for a good log of mahogany —and few probably of the visitors at the International Exhibition gave a second glance at the huge squared log of mahogany, which was shown in the Haytian Court, worth many hundreds of pounds, or reflected upon what might be its ultimate destination when sawn or cut into veneers. The principal sources of supply for this wood are Belize, British Honduras, which furnishes one half, St. Domingo, Cuba, and Mexico.

Spanish mahogany imported from Cuba, Hayti, and other West India islands, is in smaller logs than the Honduras, seldom exceeding sixteen to twenty-four inches square, and from six to twelve feet long. The colour is paler, the lustre less, in consequence of the medullary plates being smaller and irregularly distributed; the grain is also finer than the Honduras, and the texture harder. Many of the more expensive woods are cut into thin strips, termed veneers, which are glued on to pine surfaces, or other common woods, and by this process nine-tenths of the wood are saved.

By the use of beautifully adapted circular saws, worked by machinery, veneers are often cut of the thickness of one-fortieth of an inch, a little thicker than the sheet of paper on which this is printed. By the largest saws, logs of mahogany, three feet square, can be cut up into unbroken sheets of veneer at the rate of about ten or twelve to the inch, and so beautifully smooth as to require scarcely any dressing. The longitudinal edges of the veneers are protected by a calico band glued on, to prevent them from splitting when removed. Walnut is cut, not in longitudinal sections like other veneers, but in thin spiral sheets from the circumference of the tree. That makes the thinnest veneer of the whole, but it is frequently defective.

Rosewood, obtained from Brazil, and walnut, from Belgium and Italy, are probably, next to mahogany, the most important furniture woods.

There is still great confusion as to the trees which furnish the South American rosewood. From the Portuguese name of Jacaranda, the scientific name of *Jacaranda Brasiliana* has been applied to it. There is, however, little doubt that several species of *Triptolomea* yield rosewood in the province of Bahia.

The demand for rosewood has lately fallen off; for while in 1854, 5,670 tons, of the value of £82,211, were imported, on the average of the three years ending 1861 the imports were only 2,000 tons.

Rosewood exhibits large elongated zones of black irregular lines on a reddish brown ground, of various tints and high lustre. The grain varies,—being frequently very coarse, but in selected specimens sufficiently fine for the best description of furniture. The dark colour in general is too predominant; but when this is not the case, and the lighter ground is disposed in larger masses than usual, the wood is considered very beautiful.

Some of the specimens of Maple wood from North America are very ornamental, especially those of the red-flowering maple (*Acer rubrum*), and the sugar maple (*A. saccharinum*).

It sometimes happens that in very old trees of the former species, the grain, instead of following a perpendicular direction, is undulated; and this variety bears the name of "curled maple." This singular arrangement, for which no cause has ever been assigned, is never witnessed in young trees, nor in the branches of such as exhibit it in the trunk. It is also less conspicuous at the centre than near the circumference. Trees offering this disposition are rare, and do not exist in the proportion of one to a hundred. The serpentine direction of the fibre, which renders them difficult to split and to work, produces, in the hands of a skilful mechanic, the most beautiful effects of light and shade. These effects are rendered more striking if, after smoothing the surface of the wood with a

double-ironed plane, it is rubbed with a little sulphuric acid, and then with linseed oil. On examining it attentively, the varying shades are found to be owing entirely to the inflection of the rays of light, and this is more sensibly perceived in viewing it in different directions by candle-light.

Before mahogany came into such general use, the wood of the red-flowering maple was largely employed in America for furniture; bedsteads are still made of it, which in richness and lustre excel the finest mahogany. Veneers of it are much used to inlay other woods in articles of cabinet work and for the finishing of ships' cabins. The red-flowering maple never produces the variety known as "bird's-eye maple," that being confined exclusively to the sugar, or rock maple. The sugar maple exhibits two accidental forms in the arrangement of the fibre, of which cabinet-makers take advantage for making beautiful articles of furniture. The first consists in undulations like those of the red-flowering maple, and is likewise known as "curled maple;" the second, which takes place only in old trees which are still sound, appears to arise from an inflection of the fibre from the circumference towards the centre, producing spots of half a line in diameter, sometimes contiguous, and sometimes several lines apart. The more numerous the spots, the more beautiful and the more esteemed is the wood. This variety is called "bird's-eye maple."

Maple is now imported in considerable quantities from New Brunswick, and fetches a high price; 413 tons, valued at £2,752, were received in 1861. The ancients held the maple in great esteem, and tables inlaid with curious portions of it, or formed entirely of its finely variegated wood, in some instances realized their weight in gold.

The principal portion of the Satin-wood that comes into commerce is brought from the West Indies, and is produced by *Maba Guineensis*, an ebenaceous tree in the Bahamas, Hayti, &c.

It is of a beautiful deep yellow colour, mixed more or less with orange and brown, and hence called, locally, "yellow wood;" is remarkably close-grained, heavy, and durable. It is sometimes confounded with East Indian satin-wood, the produce of *Chloroxylon Swietenia*, a cedrelaceous tree. The latter possesses the richest colour, whilst the West Indian satin-wood has a higher and more variable lustre. In some instances the Indian wood is beautifully patterned or flowered, and is much used for picture-frames, rivalling bird's-eye maple. Indeed, satin-wood fetches a much higher price than maple. The Chinese are very partial to this wood, and receive quantities of it from Siam. We obtain some from Ceylon and Madras.

Our supplies of the dark blackwood, known as Ebony, to the extent of 1,500 tons, are imported chiefly from the west coast of Africa, Madagascar, India, and Ceylon. It is the duramen or heart-wood of several species of *Diospyros*, and is much used for inlaying work by cabinet-makers.

Previous to the introduction of mahogany, rosewood, and other exotic woods, that of the Walnut was held in higher estimation than that of any other European tree, and supplied their places in the manufacture of the most valuable and costly pieces of furniture, examples of which are still to be seen in houses of ancient date, whose beauty in grain, polish, and pattern, would bear comparison with any of the choicest woods of the present day. Indeed, of late years we have been returning to this taste; for while foreigners prefer mahogany for cabinet work, we have taken again to walnut for suites of furniture. The imports of walnut-wood have recently averaged 3,200 tons, or double the quantity of rosewood imported.

The name Cedar is given to several woods, but properly belongs to the almost incorruptible wood obtained from two species of *Cedrus*,—*C. Deodara* and *C. Libani*. This is the cedar spoken of in Scripture: "The cedar of the house within was carved with knops and open flowers: all was cedar; there was no stone seen."—(1 Kings, vi. 18.)

The wood of the common *Cedrelas* is far less valuable. The cedar chiefly imported is *Cedrela odorata*, in logs, free from knots and straight-grained, from Cuba, Mexico, and Central America, in quantities varying from 3,000 to 5,000 tons yearly. Thirty years ago the consumption was less than half that quantity. The red or pencil cedar of Virginia (*Juniperus Virginiana*) is also imported, being serviceable for internal joiner's work. The rare beauty of the sideboard top of Australian cedar root in the New South Wales court of the late Exhibition attracted much attention.

Oak still retains its time-honoured place in Gothic furniture and libraries. Wainscot oak is imported in logs from the Baltic, for cutting into planks or slabs for furniture, or for panelling rooms.

Having noticed the principal woods imported in quantity, we may now incidentally glance briefly at a few others deserving of mention. And here it may be remarked that nearly all the ornamental woods used are derived from tropical countries, although occasionally specimens of woods grown in temperate regions are characterized by considerable beauty. Thus the curled ash of Canada, from the beauty of the figure, if better known, would be much appreciated by our timber merchants, the pattern resembling the renowned Hungarian ash, a wood

which was in great favour here at one time, and realized a high price, but could not be obtained in large planks.

The Laburnum has a wood of a darkly variegated colour, rendered more beautiful by a lustre of metallic green, and when knotted is equal to mahogany. The medullary plates, which are large and very distinct, are white, and the fibres of a dark brown, a circumstance that gives quite an extraordinary appearance—a peculiarity not to be observed in any other wood.

Incidental mention has already been made in the Notes on the Exhibition,* of some of the fine woods of our colonies; but as yet scant justice has been done to them in the way of publicity, either in the Jury Reports or through any other medium. Such a magnificent collection of woods of all kinds, many of them new and rare, from different countries, was never before brought together, and it is very doubtful if it ever may be again.

Many of these woods are as yet comparatively unknown; the difficulties in the want of labour, proper roads, and available means of transport, have hitherto prevented the various treasures of our colonial forests from becoming readily accessible to the requirements of our artizans.

Numerous illustrations were afforded of the suitability of many of these woods for furniture, for smaller articles of turnery and ornamental workmanship, and for parti-coloured work in marquetry, wood mosaic or Tunbridge ware, and Sorrento inlaying. Innumerable specimens of cabinet-work, of the highest excellence, were seen to great advantage, and obtained universal commendation from competent judges.

Many of these elegant pieces of ornamental work displayed the peculiar beauty and figure, the closeness of grain, and, in some cases, revealed the fragrant odours of the smaller woods, and showed how well they are deserving of more extensive notice than they have hitherto received. Many of the woods exhibit a peculiar beauty of structure; some are highly fragrant, and retain their agreeable odour for a considerable period of time, which renders them additionally pleasant and acceptable in the form of ornamented articles to the boudoir and drawing-room.

Some of the rarest and most esteemed ornamental woods are South American, and come chiefly from Brazil; among these are tulip-wood, zebra-wood, the produce of *Omphalobium Lamberti*, king-wood, canary-wood, partridge and pheasant wood, and purple-wood.

Coromandel or Calamander wood is the produce of an ebenaceous tree of Ceylon, and considered, from its peculiar marking,

* "Popular Science Review," No. VI.—"The Colonies," &c.

one of the handsomest of the brown woods. It is getting scarce. Kingwood and zebra-wood are rich yellowish-brown, striped; sometimes full of zoned eyes.

A valuable, heavy furniture wood of British India is the blackwood, locally called rosewood, obtained from the *Dalbergia latifolia*, a leguminous tree. It can be procured in any quantity, and of immense size, but in large panels is liable to split. Jackwood (*Artocarpus integrifolia*) furnishes a yellowish wood, which deepens into brown. When made into tables and well kept, it attains a polish little inferior to mahogany. The Chittagong wood (*Chickrassia tabularis*) is more used in Madras for the making of furniture than any other wood. It is light, cheap, and durable.

Lingoa wood, the Amboyna wood of commerce, was imported into this country in considerable quantities from the Moluccas during the time those islands were British possessions. It is stated to be abundant at Ceram, New Guinea, and throughout the Molucca seas. The wood can be obtained in any quantity if the precaution be taken of ordering it during the previous season. Circular slabs of Amboyna wood are occasionally met with as large as nine feet in diameter; but the usual size is from four to six feet. These slabs are obtained by taking advantage of the spurs which project from the base of the trunk, as the tree itself has not sufficient diameter to furnish such wide slabs. The kayubuka of commerce, so much esteemed as a fancy wood, is obtained from the gnarled excrescences which are found on these trees (*Pterospermum Indicum*.)

In the beauty of its duramen the blackwood of Australia (*Acacia melanoxylon*), also known as lightwood, possesses many resemblances to the best walnut, and is considered even superior to that wood, being harder and more durable. It is a favourite wood with the cabinet-makers of Victoria for furniture of every description, and receives a very high and beautiful polish.

There is one other very ornamental wood which has lately been largely used in cabinet work by the French,—the cypress of Algeria (*Thuja articulata*). The wood is dark nut-brown, close-grained, and very fragrant. It is believed to be the *algum* or *almuz* of Scripture, one of the most costly materials furnished by Hiram, king of Tyre, to Solomon, for the building of the Temple, and for the house of Mount Lebanon. Planks of this wood formed the precious citrine tables of the Roman banqueting halls.

It requires a large capital to keep up a good stock of seasoned wood, so as even to support a moderately large manufactory; but as there are no duties on wood, it pays the dealer well to

lay in a stock of furniture wood for seasoning, because the unexampled prosperity of our colonies insures for a long series of years a market for the furniture of Europe. Nothing but the taste and make of the mother country will suit her colonists, and skilled labour is too high in the colonies for much attention to be given yet to furniture and cabinet-making. The value of the furniture, cabinet, and upholstery wares annually exported from the United Kingdom averages from £250,000 to £350,000.

There was a time, we are told by a leading Liverpool timber firm, when a portion of the capital of that county (Lancashire) employed its population in the manufacture, and its merchants in the exportation of furniture. The foundations of the fortunes of the more prosperous cabinet-makers and shipowners were so laid. Circumstances, however, interrupted this state of things, through the imposition of war duties of £12. 10s. per ton on Spanish mahogany, and £45 per ton on rosewood; and Lancashire ceased to employ its people in the manufacture beyond the home trade, and its merchants ceased to load the 'tween decks of their ships with furniture to the colonies.

FOSSIL BIRDS.

BY S. J. MACKIE, F.G.S. (EDITOR OF "THE GEOLOGIST.")

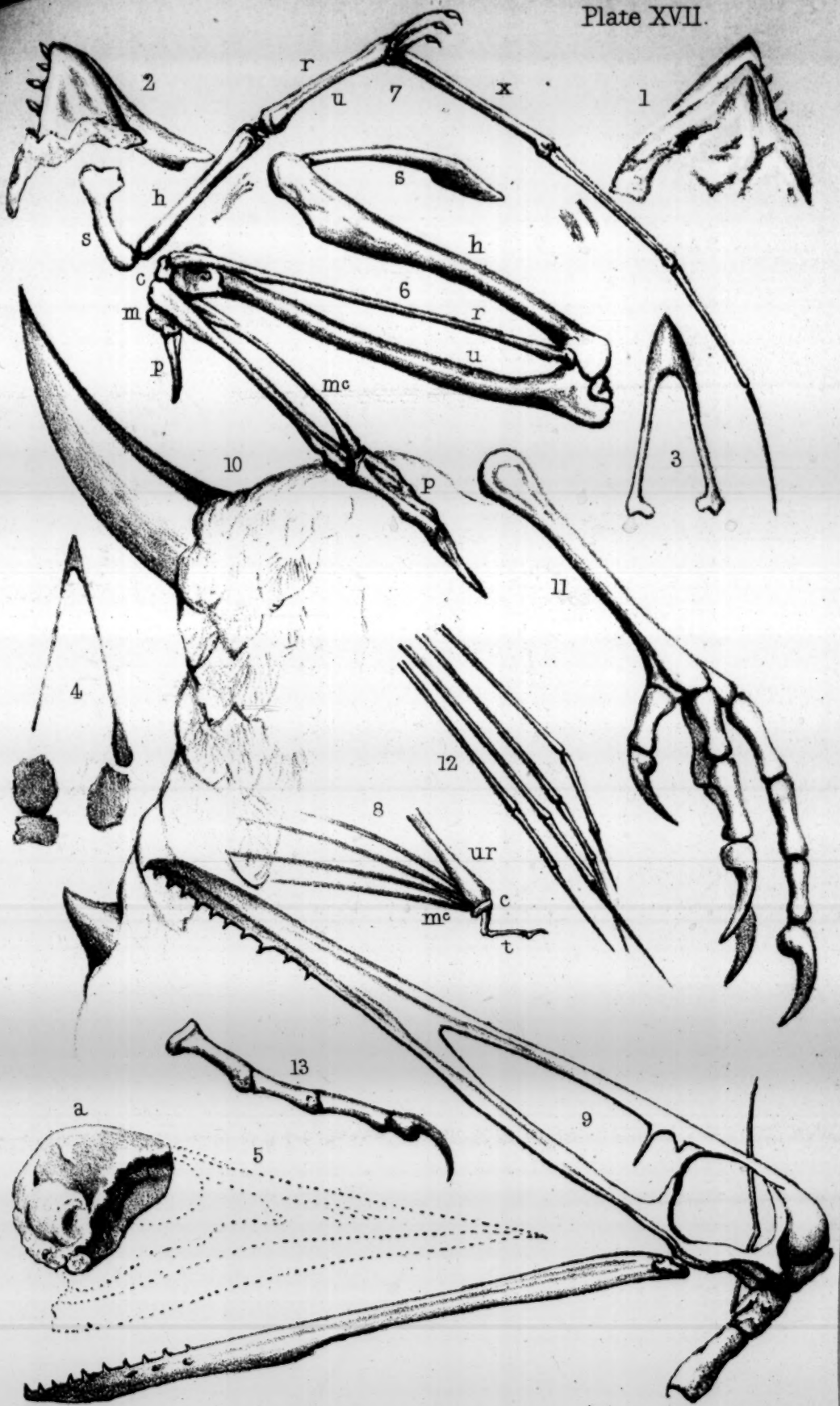
OF all the wonderful applications of vital force as a mechanical power to the locomotion of solid bodies, that of flight is the most marvellous; and delighted as we are with the cheerful voices and painted plumage of birds, their graceful and rapid motions through the air equally attract our attention.

In the far past exhibited by Geology, we look back to a pristine age of shell-fish and "creeping things." Then follow fishes, smoothly gliding through the sea — nicely-balanced aquatic balloons that rise and fall by voluntary compression or expansion, and propel themselves by the strokes of side-paddles or the lateral lashings of a rudder-like tail. Next, amphibious life—great reptiles basking in the sea, and sluggishly crawling over the muddy shores. Then, an age of mammals—browsing herbivores, fierce carnivora, flat-footed bears, ponderous elephants, fleet deer and horses—walking on four props or legs on the firm land. Now we see four-handed beasts swinging with easy agility from bough to bough, and tree to tree—vegetarian inhabitants of the woods—and two-footed, two-handed man walking erect, and master of the earth.

From the earliest records of the earth's history that we possess, the idea of *flight* seems absent; and it is not until we have passed the vast Palæozoic age, and entered the secondary epoch of the earth's crust-formation, that we find any trace of this idea. Then, indeed, we find foot-prints of perhaps wingless, or nearly wingless, birds; but scarce a bony relic of all the thousands that trampled on the yielding shore, and left "their foot-prints on the sands of time." The first of birds, so far as we can learn from their foot-prints, were cursorial—runners like the ostrich, or rather like the rhea. We have no evidence to show they could accomplish long or lofty flights; but, on the contrary, all the little that we know seems to prove that their wings were rudimentary, and only assistant to their velocity of pedal progression.

Then follows a long silence, broken, as it were, by whispers, and a few decisive words—a few bones, here and there, in the cretaceous and oolitic beds—and then the wonderful Archæopteryx. But during this long silence *flight* was a prominent feature of animal motion; and that, too, in perhaps its most

Plate XVII.



A. Mackie lith.

W. West imp.

Fossil Birds.

singular phase. Astonishing in their vast proportions as are the fossil reptiles of the Jurassic ages displayed in gigantic models in the pleasure-grounds of Sydenham, still more astonishing are other reptilian relics of those marvellous times. Then it was that reptiles *flew*. Sluggish as are now presented to us the cold-blooded crocodile, frog, and turtle, reptiles then spread an expanse of leathern wing of sixteen feet, and took, perhaps, long and unwearied flights. What lives they led no man yet has told. But who can look on their petrified forms, and not feel a strange inquisitiveness about their habits? Were they ceaselessly on the wing, like the summer swallow after insect-prey? We think not, although there were great insects in those days—dragon-flies, beetles, grasshoppers. Hovering like hawks, did the little spalacotheria, triconodons, and plagiaulaxes tremble under the dark shadows of their sombre wings? We think not, although the bones of those tiny mammals swarm in the Purbeck beds. Like the albatross did the pterodactyles travel for days together over the watery main? Or, like the sea-eagle, did they swoop down on the placid fish as they came to the surface of the briny deep? We are not aware that any one yet has made a guess as to *what* the Pterodactyles fed upon; but we think it would be worth while to inquire whether the numerous cuttle-fish of those ages may not have been one source of nutriment.

In the Gault, near its junction with the Lower Greensand, there is a thin but regular stratum of broken ammonites impacted in a phosphatic paste, and very probably of coprolitic origin. May not this stratum have been derived from the excrements of the Wealden Pterodactyles? That they swarmed in our British area is evident from the quantities of their bones found with the nodules of the Cambridge Greensand; and if it be said that the Upper Greensand is a superior stratum to the Wealden beds, it might be urged on the other hand that it was probably a deeper sea deposit of contemporaneous age. The Iguanodons of the Wealden era *are* found in the Lower Greensand, why should not the Pterodactyles, whose bones and *débris* occur at Cambridge, have floated on their wide-expanded wings over the tangled forests of the ancient Weald?

It seems at first sight perfectly astonishing how few remains of birds have been preserved in a fossil state; but when the fragile pneumatic structure of their bones is taken into account the wonderment decreases. Still it does not cease, for we find the flying-lizards' bones preserved, and they are filled with air-cavities as are those of birds, although perhaps the bones themselves may be of stouter or more solid build. The true explanation of the matter seems to be that birds dying on the land were exposed uncovered on the ground, not only to the eyes of

carrion-eating birds and beasts and to the attacks of insects, but were also subjected to the most powerful means of decomposition and decay—atmospheric influences. Moreover, the traces of former terrestrial surfaces have been very seldom preserved, and the instances that do occur are restricted in area and very rare indeed.

The first evidence that we have of birds, is in the Red Sandstone of Connecticut, formerly considered of Triassic but now believed to be of Oolitic age. Amongst the bird-prints of this rock, and they belong to many species of very different sizes, are some of gigantic dimensions, belonging, apparently, as we have said, to struthious birds. Wherever the rock is extensively quarried these large footprints are sure to be seen, and they are found throughout the whole thickness of the beds, amounting to many thousand feet. The ordinary stride of the bird was about three feet, and the length of the impress of its foot nine inches. There are, however, other footprints in this rock still more gigantic, measuring up to eighteen inches, belonging to birds that had a stride of five feet at every step they took. But although birds from these evidences have been known to have existed during the period of the Connecticut sandstone, since 1835, when Dr. Deane communicated his discoveries to his scientific friends, up to this hour only a few indeterminable bones have been met with.

In 1857 Dr. Emmons made known, under the name of *Palæornis struthionoides*, a portion of the sacrum of a bird containing six vertebræ anchylosed together, from the red and variegated sandstones of Anson County, North Carolina. The description of these ornithic remains is included by Dr. Emmons in his notice of the palæontology of the American Trias; but the nature of this relic and the possibility of its belonging to a large and heavy struthious bird would incline us to question its right to be referred to that age, until the actual period of the Connecticut sandstones, and the relationship of these red sandstones of Anson to them, is completely established.

The next evidence of the ancient existence of birds occurs possibly in the Wealden beds of the South-east of England. From time to time the late Dr. Mantell had obtained some fragments of delicate bones from the strata of Tilgate Forest, which he conceived to have ornithic characters, but the accuracy of this view was put in doubt when the so-called bird-bones from the Stonesfield slate were proved to have belonged to pterodactyles. Some further specimens, however, were obtained and submitted by Dr. Mantell to Cuvier and to Owen. Strengthened with the confirmation of such eminent authorities, the Doctor announced positively before the Geological Society in 1835 the existence of bird-remains in the Wealden forma-

tion, suggesting their typical resemblance to the corresponding bones in the heron (*Ardea*). These remains have received the classificatory appellation of *Palæornis Cliftii*. Subsequently, in 1845, Professor Owen retracted his opinion, and in a paper before the Geological Society expressed his conviction that these so-called birds' bones were really those of Pterodactyles. Dr. Mantell contested this recantation; and thus the matter remains. In 1857 the Rev. Mr. Dennis, of Bury St. Edmund's, proved, by an examination of the microscopic structure of some fragments of bone from the Stonesfield slate, the existence of birds at that epoch. The next traces of birds in time are the fragments found in the Upper Greensand of Cambridge by the late Mr. Lucas Barrett, who so sadly lost his life a few weeks since in a submarine exploration off the shores of Jamaica.* Of these remains or their relations we are unable to speak. They are not preserved at Cambridge; nor can Mr. Harry Seeley, the curator of the University collection, afford us any information about them. In the museum at Philadelphia, U.S., there are birds' bones from the Greensand of New Jersey—the equivalent of the European "Senonian," or Upper Chalk age —which have been referred by Dr. Harlan to the genus *Scolopax*, or snipe.

With the dawn of the Tertiary period, birds' remains become more numerous and varied in character. Cuvier has recorded eleven species from the gypsum of Montmartre. Owen has described the breastbone and sacrum of a vulturine bird from the London clay, of a smaller species than any now existing; Jourdain and Gervais have recorded bird-remains from tertiary strata of the south of France; and the German palæontologists others from the Miocene or middle tertiaries of Weisenau and Wiesbaden. From the Eocene period then there are species of turkey-buzzard (*Cathartes*), vulture (*Lithornis vulturinus, Lithornis? emeuinus*), bald buzzard (*Pandion*), owl (*Strix*), protornis (*Protornis Glarisiensis*), kingfisher (*Halcyornis toliapicus*), curlew (*Numenius gypsorum*), snipe (*Scolopax*), sea-lark (*Pelidna*), sandpiper (*Tringa*), pelican (*Pelicanus*), and gastornis (*Gastornis Parisiensis*).

Of the Miocene age we have species of thrush (*Turdus*), finch (*Fringilla*), partridge (*Perdix*), fowl (*Gallus*, sp. and *Gallus Bravardii*), flamingo (*Phœnicopterus Croizeti*), stork (*Ciconia?*), heron (*Ardea*), snipe (*Scolopax*), coot (*Fulica?*), corvorant (*Phalacrocorax*), duck (*Anas*), merganser (*Mergus Ronzoni*).

In the Pliocene: falcon (*Falco*), snipe (*Scolopax?*), and wild swan (*Cygnus ferox*).

From caverns and diluvial deposits there have been

* For a brief sketch of his life, see "Summary of Geology."

exhumed remains of turkey buzzard (*Cathartes*), vulture (*Vultur cinereus*), sparrowhawk (*Nisus*), falcon (*Falco*), buzzard (*Buteo*), eagle (*Aquila*), two or three common owls (*Strix*, two sp. and *S. nyctea*), and the screech owl (*Bubo*), wagtail (*Motacilla*), thrush (*Turdus*, sp. and *T. Bresciensis*), anabate (*Anabates*), swallow (*Hirundo fossilis*), finch (*Fringilla*, sp. and *F. trochanteria*), lark (*Alauda*), three or four crows and the raven (*Corvus fossilis, C. crassipennis, C. corone* vel *corax, C. pica ?*), woodpeckers (*Dendrocolaptes, Picus martius*), coua (*Coccyzus*), barbet (*Capito*), parrot (*Psittacus*), swift (*Cypselus collaris*), goatsucker (*Caprimulgus*), dove (*Columba*), dodo (*Didus ineptus*), solitaire (*Pezophaps solitaria*), grouse (*Tetrao*), partridge (*Perdix*, two sp.), pheasant (*Phasianus*), common fowl (*Gallus domesticus*), Guinea fowl (*Numida*), tinamou (*Tinamus*), nandù (*Rhea*, two sp.), dinornis (*Dinornis ?*), æpyornis (*Æpyornis*), buzzard (*Otis*), cariama (*Microdactylus*), stork (*Ciconia alba*), flamingo (*Tantalus Bresciensis*), snipe (*Scolopax*), rail (*Rallus*, two sp.), gull (*Larus priscus*, and *L. sterna ?*), swan (*Cygnus olor*), goose (*Anser*), duck (*Anas*, two sp.), and diver (*Colymbus*).

It will be here right to observe that it is more than doubtful whether the remains from caverns should be considered as of one age. The *Machairodus*, or great British tiger, is not believed to have lived down to the Post-Pliocene age, and yet its remains are found mingled with Post-Pliocene Mammalia in Kent's Hole and other caverns.

It may be that many of the caves and fissures containing osseous breccia, mammal, and other bones, were open during the Miocene age; and if one considers how long bones might remain under such circumstances uncovered by any preserving or time-separating deposits of mineral matter, it is easy to conceive how, by the tread of wild beasts, the irregular falling together of the bones themselves, as their muscles and ligaments decomposed, and by various other natural causes, a commingling in cave-accumulations of the relics of widely distant epochs could, and doubtless did, take place.

Alluvial deposits are, of course, the link between the past and present. As yet, however, they have been little worked, for the relics of this border-land between past and present time have not found much favour in the eyes of the geologist, and as little in those of the archæologist or naturalist.

The remains of dodo (*Didus ineptus*), solitaire (*Pezophaps solitaria*), two species of the singular wingless apteryx, ten or more species of the gigantic dinornis of New Zealand—some standing ten feet high, and some with three-toed feet twelve or fifteen inches long, three apteryx-like birds (*Palapteryx ginens, P. dromioides, P. geranoides*), aptornis (*Aptornis*), and

the æpyornis (*Æpyornis*) of Madagascar, and its enormous eggs, capable of holding two gallons of water. These and the recently extinct moa (*Moa*), and notornis (*Notornis Mantelli*), of New Zealand, are sufficient to show the interest of the relics from alluvial strata, and the necessity of a better knowledge of their contents. The search after the early traces of Man will no doubt be ere long prolific in results to the naturalist, as well as to the anthropologist; and the knowledge of the animals and plants with which the pristine races of our kind were surrounded will be a subject of the greatest interest.

The above enumeration gives all the cases of bird-remains from every part of the world that are at present known; and as it is the full account of a whole class of animals, it shows very decisively the positive imperfections of the geological record as at present eliminated.

When Darwin first made the bold assertion that there were great gaps in the geological history, there was some disposition in scientific quarters to meet his assertion with scornful denial. Geologists had so prided themselves on what they had done, that they had never thought about what had been left undone; and it was soon found when reflection was turned to the subject that it was impossible for such a statement to be gainsaid. Attention has now been forcibly drawn to the fossil remains of this particular class by the discovery of an extraordinary bird in the lithographic slates of Pappenheim. This creature, so beautifully preserved that even the impressions of the feathers in the stone are retained, was first made known to the world as a supposed "feathered reptile," and has been lately purchased for the British Museum, and admirably described by Professor Owen. (Fig. 14.) As accounts of this extraordinary fossil have appeared in almost every daily and weekly journal, we need do no more than briefly refer to its prominent points, and the history of its discovery. In 1861, M. Andreas Wagner communicated to

FIG. 14.

the Academy of Munich an account of the discovery of a fossil with divergent fans of feathers, of which he had been informed by M. Witte, the mayor of Pappenheim. Wagner, who was very ill at the time, in fact dying, never saw the specimen, but concluded, from the description he had received, that the remains must be those of a reptile, and named it the *Griphosaurus*. The familiar presence in the same beds of lithographic stone of flying reptiles, the Pterodactyles, aided Wagner's error, and a *furore* was created in the scientific world. After Wagner's death, the fossil was purchased from M. Häberlein, of Pappenheim, in whose collection it was, for our national collection,—not under the idea, however, that it was a feathered reptile, for both Professor Owen and Mr. Waterhouse were satisfied of its ornithic nature.

Bird-remains, so perfect and so extraordinary, and from so ancient a stratum, were, however, a desideratum of the highest scientific importance, especially when the creature possessed the extraordinary character of a long *vertebrate* tail.

After Professor Owen's elaborate and accurate examination, no doubt can remain as to its bird-like nature—the presence of a furculum or "merrythought," and the "perching" form of the leg and foot, with many other less prominent features, are sufficient to establish this. But it will be desirable to notice some of those abnormal characteristics which render it so very remarkable in a zoological point of view, and which make it imperative to show distinctly that it does not possess reptilian characters. The powers of flight possessed by the Pterodactyles, the long vertebrate tail of one of them—the *Rhamphorhynchus*—found in the same strata with the Archæopteryx, and the general tendency of naturalists to seek for, and perhaps too readily to accept, any evidences, supposed or real, of a transmutation of species, have in the present case fostered the original idea of a "feathered reptile," and led to a wide-spread readiness to accept the, as yet, untenable doctrine of the transmutation of flying reptiles into birds.

Flight is not the peculiar property of birds alone, although they possess it in a degree of perfection unknown to any other animal, and although through it they are clothed in garments of such exquisite delicacy and beauty; so essentially is it the prominent idea of their whole structure, that we have not only universally come to regard it as their special attribute, but as universally to view the bird as the typical and bodily expression of the *idea* of flight. Still, the bat flies, and the flying-squirrel (*Pteromys*) on outspread wing-sails shoots from bough to bough. Yet both are mammals; in the one the long fingers of the fore-arms spread out the side-skin into wings (Plate XVII., fig. 8); in the other it is but the same loose expanded skin that

forms the sail. But the structure of the bird's wing is altogether different. The humerus bends back from the scapula (Fig. 6), the ulna and radius form the remige of the wing to which the quill-feathers are attached; while the carpals and metacarpals of the second and third digits form the pinion, and the carpals and metacarpals of the fourth digit are anchylosed together and form a little undeveloped finger of bone at the joint of the wing between the remige and the pinion. In the wing of the Pterodactyle (Fig. 7) the little finger is made to do duty as the yard to spread the sail of leathern skin, while the rest of the fingers provided with strong hooked claws extend beyond the wing-joint as clutches for the monster to hang on by, as bats and vampires do, to points of rock or boughs of trees.

The wing of the Archæopteryx has one or two claws (Fig. 15), or rather hooks, but so have recent birds. The *Parra jacana*, the *Palamedea*, the "spur-winged goose," the Syrian blackbird, are all examples. These claws—and in the Archæopteryx there might be, Professor Owen thinks, possibly three—are particular developments of those digits which ordinarily in birds are modified and disposed to form the pinion of the wing, and are not to be necessarily considered as in any way equivalent to the wing-finger of the Pterodactyles. They may have been used as hooks, but that they were so is not certain; and in the spur-winged birds the spurs are generally pointed, and usable apparently only as weapons of offence or defence. (See the Chaja Screamer, Plate XVI., fig. 10.) The reason, it is said, that "possibly the Archæopteryx had these two or three wing-hooks, is that these bones are displaced in the slab, and therefore *may* have been *washed* together. There is reason, however, to think that other osseous remains lying near to the hooks may be carpal bones.

FIG. 15.

The form of the foot in the Archæopteryx is also decidedly that of a bird (Fig. 11). Its specialities may perhaps be best seen by a comparison with that of the Falcon (Fig. 13), or some other strong-footed, retractile-clawed, raptorial bird, between which class and the Perchers, the Archæopteryx will probably take zoological rank. In the *Geologist* for January last I pointed out the particular organs indicated by a cast of the brain-cavity of the skull, which has been remarkably preserved in the stone; and I would here draw attention to another portion of this wonderful fossil, which has hitherto received no published notice.

While the Archæopteryx slab presents us with the bones of the wing, the furculum, the ribs, the ischium, the numerous vertebræ of an extraordinary and long tail, into which the feathers were set in pairs,—while the imprints of these feathers

are, as well as those of both wings, most delicately preserved, Professor Owen, in his wonderful description before the Royal Society, made no mention of the head; and that portion was believed to be absent from the block. I had, on the first occasion of seeing the reverse of the Archæopteryx block, noticed a ring of spar, which I considered as representing a part of the skull. A friend, to whom I showed it, differing in opinion, I did not press the point. Moreover, the block itself was under examination by Professor Owen at the time; and common courtesy demanded that I should not use any facilities afforded to me by the officers of the national collection in anticipation of the labours of so able and so competent an anatomist.

Some time after the reading of Professor Owen's paper, when Mr. John Evans,—struck with the resemblance of the concretion that had been formed within the ring of spar above noticed, to the two lobes of the brain,—made a cast of the brain-cavity of a crow's skull, my attention was re-directed to the subject, and I made a careful comparison of a bird's brain with the Archæopteryx concretion, and pointing out the actual parts of the brain shown in it, demonstrated (I suppose to the satisfaction of palæontologists, as no one has disputed my conclusions) that this cast represented the fossil brain of that creature. This evidence was confirmatory of the previous conclusions of Professor Owen, as to the ornithic nature of the fossil; for the characteristics of reptilian brains are so distinct from those of birds, that no tyro in anatomy could mistake the differences. If, therefore, "the feathered reptile" theory had any basis in fact, the Archæopteryx brain should have presented a pterodactylian, or reptilian organization, and not have agreed in every typical feature with the brain of a common bird.

Since the discovery of the brain my attention has been drawn to some very indistinct portions of crystalline substance on the surface of the slab, representing bone; for all the bones of the Archæopteryx are changed into calcareous spar, in which four or five little sparry points are to be seen. Mr. Evans, we are told, first detected these points, and assumes they are, or may be, teeth. From this he has inferred that the portion in question might be the jaws of the Archæopteryx. Mr. Davies, of the Palæontological Department of the British Museum, differed from this view, and pointed out to me specimens of fish of the same geological age as the Archæopteryx, with which he thought they agreed in form; regarding the bones with which they were associated as the maxillaries, &c., of a fish's head. As I was not, for zoological and anatomical reasons, disposed to believe that a bird's *beak* could be armed with teeth, I was inclined to accept Mr. Davies's explanation.

The "fish-head" theory did not, however, rest easily on my

mind. I could not conceive why a fish's head should be mixed with the Archæopteryx's bones, instead of its own. The principle of taking another man's hat when you have lost yours did not apply. The fossil, like Conrad Gesner's "dragon," or the Japanese monster in the *Field* window in the Strand, was not made up of the head of one thing, the body of another, and the tail of a third. It was not a compound of the body and legs of a bird, with the tail of a Ramphorhynchus and the head of a fish, but was a veritable fossil undoubted from end to end and top to bottom. How a fish's head could get there, without any other trace of its body, fins, bones, or tail, was puzzling—not even a scale; and the lepidoid fishes—to which order, if any, this head, if it were one, must be referred—had thick, hard scales, which would not easily decay, and which could not, if there were any in the stone, be overlooked. Nothing but the head! seemed so strange that I was induced to make a careful comparison of the supposed fish-head with the inverted beak of a bird, to which a close inspection had led me to think it bore a resemblance.

Selecting purposely the skull of a raptorial bird, by the kindness of Mr. Geo. Gray, the opportunity of comparing it with the skull of the *Aquila Bonelli* has been afforded me; and, as I believe, with the probability of a useful result. I speak diffidently, because these particular bone-remains, so obscure as to have passed under the keen and scrutinizing eyes of the Superintendent of the British Museum without detection of their nature, are not data upon which one could be at all disposed to speak reliantly. Still, however, having come to the conviction that these shattered and altered remains (Plate XVII., figs. 1, 2) *may be* the veritable beak of the Archæopteryx, it is but right to make known the ground for that opinion.

Suppose, then, that the beak with the nasal bones, which are thin at the part joining on to the cranium, had rotted off, and had fallen, or been washed backward on to the mud, where they rested in an inverted and upturned position, ultimately by the pressure of the stony matter above becoming flattened and distorted. In this position the under surface of the fore part of the head would be seen; and supposing the lower mandible to be absent, we should have this enigmatical part of the fossil displaying the edge of the pre-maxillary and the indented impression of the upper side of the bill, a pterygoid plate on each side, and the two palatals either anchylosed together, or pressed up flattened in the inner space. But seemingly the lower mandible remains, with its rami pressed down over the pterygoid plates, to the shape of which it nearly conforms; so indistinct, however, is this portion, that it will be very difficult to assure oneself what it is.

That the breaking off of the beak in this way might happen, other fossils testify; as, for example, the Sheppey cranium figured by Koënig in his "Icones" as a *Larus*; and by Professor Owen in his "British Fossil Mammalia and Birds," as *Halcyornis toliapicus* (Plate XVII., fig. 5*a*), from which the beak is entirely absent. The figures of the lower mandibles of the Montmartre birds given in Cuvier's "Ossemens Fossiles," show what kind of traces they would leave (Figs. 3, 4), and some markings on the Archæopteryx slab are singularly like the imprint in Cuvier's Plate 155, fig. 1 (see Plate XVII., fig. 4).

In the British Museum there are many specimens of much interest besides this transcendentally valuable and instructive Archæopteryx. There may be seen limb-bones of the gigantic Dinornis, the New Zealand Moa, and the enormous foot-tracks in the Connecticut sandstone. There also are specimens of fossil feathers from Bonn and Aix, and the wonderful eggs of the Æpyornis. There too are strange unnamed bones from the Sivalik Hills of India. And these bird-remains may possess a higher interest hereafter for our readers when they know how rare are the fossil remains of the ancient inhabitants of the air.

EXPLANATION OF PLATE XVII. AND WOODCUTS.

Figs. 1 and 2. Supposed beak of Archæopteryx, or fish-head (Fig. 1 being the impression in the Archæopteryx slab of the beak, or fish-head, Fig. 1, in the counterpart of the slab).

Figs. 3 and 4. Lower mandibles of fossil birds from Montmartre.

Fig. 5. Cranium, without the beak, of the Sheppey bird (*Halcyornis toliapicus*).

Fig. 6. Wing of bird (*Falco peregrinus*). *s*, scapula; *h*, humerus; *u*, ulna; *r*, radius; *c*, carpals; *m*, *mc*, metacarpals; *p*, phalanges.

Fig. 7. Wing of Pterodactyle. *s*, scapula; *h*, humerus; *r*, radius; *u*, ulna; *x*, pinion (= little finger of human hand).

Fig. 8. Part of wing of bat. *u*, *r*, ulna and radius; *c*, carpals; *mc*, metacarpals, or wing-fingers; *t*, wing-hook (= human thumb).

Fig. 9. Head and jaws of Pterodactyle (*P. longirostris*).

Fig. 10. Part of wing of Chaja Screamer (*Chauna chavaria*), with two wing-spurs.

Fig. 11. Foot of Archæopteryx (natural size).

Fig. 12. Foot of a long-tailed Pterodactyle, from Pappenheim (natural size).

Fig. 13. A foot-claw of Falcon.

Fig. 14. Fossil remains of the Archæopteryx (about one-tenth linear). *c*, costæ; *s c*, scapula; *h*, humerus; *u*, ulna; *r*, radius; *i*, ilium; *f*, femur; *t*, tibia; *mt*, metatarsus; *p*, phalanges; *br*, brain; *b*, supposed beak, or fish-head; *x*, *x'*, carpal- or wing-hooks.

Fig. 15. Carpal-hook or wing-claw of Archæopteryx (natural size).

THE NATURAL HISTORY OF A BEECH TWIG.

BY HARLAND COULTAS.

EVERY part of a tree, whether it be leaf, shoot, branchlet, or branch, represents exactly the organic condition of the tree at an earlier period of its life, and one of the stages of development through which the entire tree itself has already passed. For it is plain that the tree was, at the commencement of the first year of its life, a single leaf; and at its close, a green herbaceous shoot, exactly like those annual growths which it now makes at the sides and extremities of its branches. In the spring of the second year, the buds formed by the leaves of the first year at the sides and summit of the first year's growth or shoot, developed into new growths or shoots, which were constructed after precisely the same pattern as the first year's shoot. They presented in autumn, when defoliated, precisely the same external appearances, having side and terminal buds, and the same peculiar form of leaf-scar. We are, therefore, necessarily led to regard them as only a repetition of the first year's shoot. For as the leaf is a unit, through the repetition of which the first year's shoot is formed, so, also, is the first year's shoot itself a unit, but of a higher and more complex character, through repetition of which the branches, and ultimately the entire tree itself is constructed. The whole tree is therefore represented in each of its parts, and if we take the terminal branches or twigs of a tree, and study them carefully, we shall obtain correct views not only of the tree during the first years of its life, but of those general and peculiar laws of growth which govern the entire tree itself.

To render the principle of these researches clearly understood, we have selected a beech twig, which the accompanying plate most faithfully represents.

By looking at Plate XVIII. the reader will see that the primary or central axis of the twig has put forth fifteen secondary axes or side-shoots. The figures in the plate, placed opposite the annular scars left by the winter leaves, will assist the reader in estimating the amount of growth made by the twig year after year; for he has only to bear in mind that these annular scars mark the place of the bud, or the terminal growth of the twig, during the year indicated by the figures, to place, as it were,

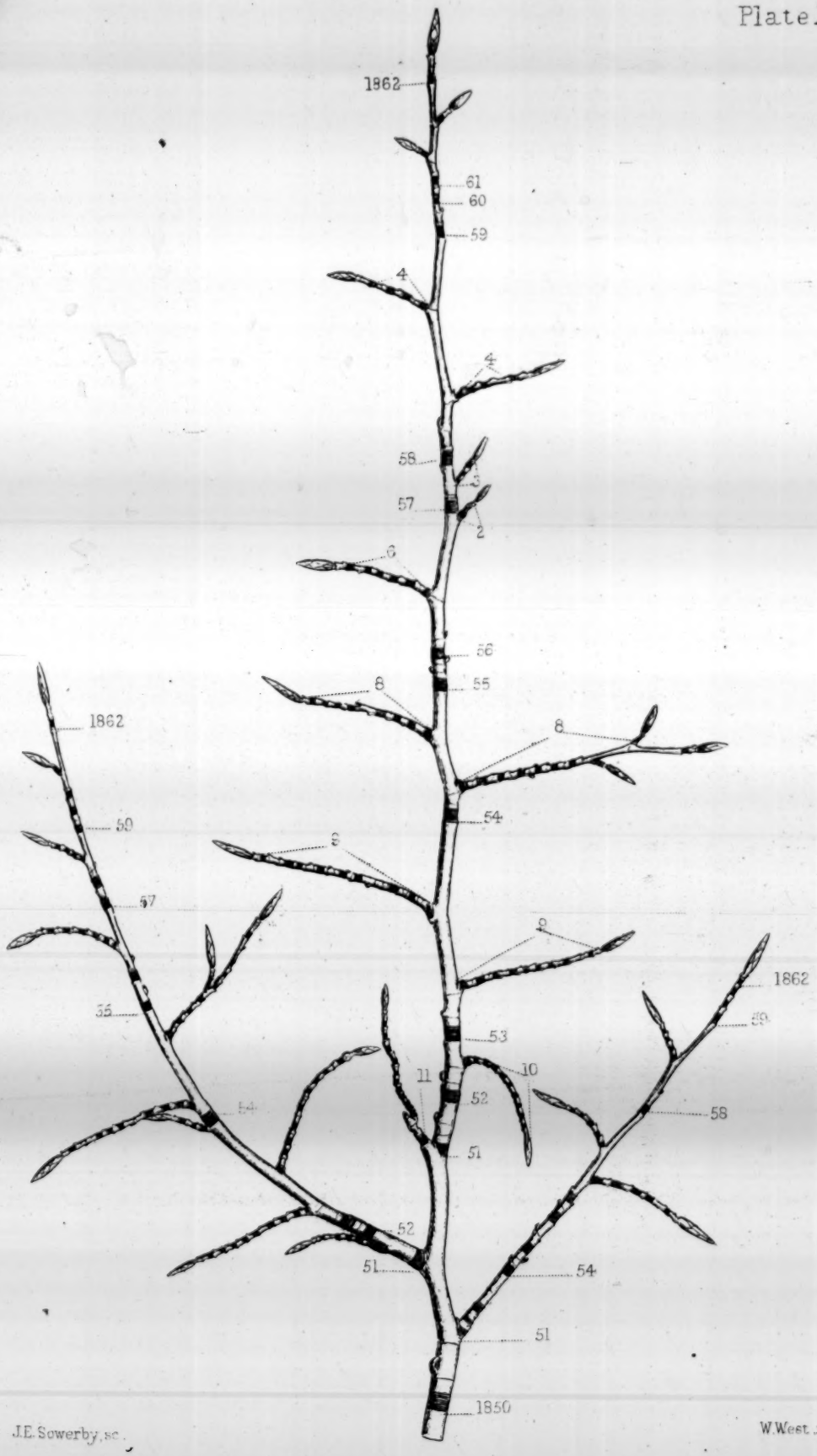
its exact vegetative condition in a moment before his eyes, at any one of the previous years of its past life.

The twig represented by our plate was cut from one of the lower branches of an old beech, in Epping Forest, on the 7th of March, 1863. As there are thirteen sets of annuli on its main or central stem, it has evidently stopped growing thirteen times, and borne thirteen generations of winter leaves, and as many generations of summer leaves; consequently it is thirteen years old, and it must have commenced growing from the bud in the spring of 1850. It is also plain, that the first and second side-shoots remained in the bud condition throughout the whole of the year 1850, and made their first growth from the bud in the spring of 1851. Hence, only twelve sets of annuli can be counted on these two shoots; and the same law is apparent throughout the entire series of shoots, which are fifteen in number; each is one year younger, and will be found to have one set of annuli less than its parent stem. Thus the fifth branch above, the set of annuli marked 53, is numbered 9, because there are on its surface the marks left by nine generations of winter leaves, or nine sets of annuli; it is therefore nine years old, or one year younger than its parent axis, which numbers ten sets of annuli, counting from annuli marked 53 upwards, to 1862. Similar observations apply to shoots numbered 8, 6, and 4.

We must, however, except shoot 11 numbered 3, and shoot 10 numbered 2. These shoots were formed from buds which were matured in the autumn of 1857 and 1856, or five and six years ago. This is proved by the leaf-scar at the base of the shoot. Yet there are only three sets of annuli on one, and two sets of annuli on the other; consequently the former shoot must have been torpid for two, the latter for four years.

Another feature which presents itself for consideration, is the variation in the amount of stem between the sets of annuli. This shows that the growth varies from year to year, and that powerful growths are sometimes followed by growths greatly retarded. All twigs over whose surface the progress of yearly growths may be traced for a series of years, show more or less these marked differences of growth. Each branch has, in fact, its own peculiar history of growth, and trees differ not more widely in this respect than two branches on the same tree. In the consideration of a tree, we have to deal not with a product of crystallization such as the lead tree, or the dendritic formations on a frozen window, but with matter living and organized. The tree is therefore no stiff, unyielding form, but an easily impressible body, whose growth fluctuates with the favourable and unfavourable state of the weather from year to year.

The distance between two sets of annuli, estimated from the



Common Beech: Fagus Sylvatica, L.

upper and under limit of the rings, shows the amount of shoot developed during the season. The variability of these distances, or year's growths, is seen by one glance at the plate. The growth of the primary axis appears to have been accelerated and retarded five times during the thirteen years, or between the years 1851, 1854, 1857, 1859, and 1862.

A similar amount of variability is visible in the yearly growths made by the first and second side-shoots. In these two shoots, and in the central axis or stem of the twig, there is evidently the greatest amount of active vitality, and consequently their fluctuations of growth are the most visible and variable, beyond those of any other shoots in the series.

And here we would call the attention of the reader to the somewhat remarkable circumstance, that the yearly fluctuation of growth of the second or largest shoot corresponds with those of the central axis of the twig, upon which it would seem to have been dependent, whereas the first shoot or the one situated immediately below it has a fluctuation in its growth which is entirely different from that of the central axis, by which its growth does not seem to have been at all affected.

In the other shoots of this twig, vegetative life is approaching to a state of torpor or inactivity, and hence there is a much greater amount of uniformity, not only in their yearly growths but also in the number of leaves annually produced. In the fourth shoot, numbered 10, for example, the growth and foliage appears to be approaching a minimum. For ten successive years this shoot has only unfolded its terminal bud, thrown off its winter leaves, put forth two leaves the vital activity of which has been so enfeebled that they were only able to form two lines of clear shoot annually, between the successive sets of annuli, with which its surface is almost entirely covered. This shoot is also curved, which is another indication of its fast-failing powers of life, which the other shoots do not manifest. When shoots curve in this manner, it is nearly all over with them. A year or two more and the terminal bud loses the power of throwing off its winter leaves, because the summer leaves no longer form in its interior; the bud then dies. With the death of its terminal bud and the cessation of the formation of any more leaves, the further growth of this shoot must necessarily be completely arrested.

But not only the winter leaves, but also the summer foliage leaves behind it a peculiar scar on the bark, which marks the point of the stem to which the leaves were attached, and the number of leaf-scars between two sets of annuli therefore enables us to estimate correctly the number of leaves which were put forth during that season.

Now there are fifty-four leaf-scars on the central axis of our

twig, many of which are represented in our engraving and may actually be counted in the plate if a small lens is used, such is the accuracy with which nature has been copied. The lines across the central axis indicate the position of these leaf-scars, for they are left by the stipule which was connected with each leaf as an enveloping and protecting organ. The fifteen branches, of course, originated from fifteen leaves. For instance, there are two lines visible, and three branches, between 1850 and 1851, on the central axis, which proves the attachment of five leaves to that portion of the axis. The first and second branches and the whole of the twigs with its shoots, above fifty-one, were then buds. Those buds indicate the position of three leaves which flourished during that season and brought them to maturity in autumn.

Again, there are altogether 299 leaf-scars on the side-growths of our twig, which proves it to be the work of 299 leaves. Evidence of the former presence of many of these leaves may be seen also with a glass on these side-growths in the lines and rudimentary buds left between the sets of annuli on their surface. Therefore the total number of leaves by which the entire twig was constructed was 54+299=353.

The following is a true estimate as to the size of the twig. The length of the primary axis is twenty inches and three lines, and of the largest secondary axis ten inches and eight lines, yet it is the leaf-labour of 353 leaves. The twig itself we have shown to be only thirteen years old. What then must be the immense number of leaves engaged in the construction of trees which put forth thousands of such twigs, which grow from one to two hundred feet in height, and whose giant forms have stood for hundreds and even thousands of years? Who can estimate the quantity of leaf-surface spread abroad in the atmosphere from the first commencement of growth, and the amount of leaf-labour necessary to rear such lofty and enduring vegetable monuments? The Washington elm at Cambridge—a tree of no extraordinary size—was some years ago estimated to produce a crop of seven millions of leaves, exposing a surface of two hundred thousand square feet or five acres of foliage.*

The number of leaves which a tree puts forth during the season is undoubtedly regulated by the size of the dilated portion of the leaf, that is to say, its lamina or blade; if that be narrow the leaves are found in greater numbers on the tree. Compare in this respect the quantity of leaves on a willow with those on a horse-chestnut or maple. But this law is most apparent when the lamina or blade of the leaf is abortive, as in the linear needle-like leaves of the fir and pine.

* "First Lessons in Botany & Vegetable Physiology." By Asa Grey. 1857.

These make up by their immense numbers and their persistent nature for their want of surface, and thus contribute to the growth of the branches of these trees, as completely as those which possess a true lamina or blade.

Again, the increase of leaf surface each year, as ascertained by calculations made on the original twig, was as follows:—1851, 5; 1852, 10; 1853, 14; 1854, 15; 1855, 23; 1856, 28; 1857, 29; 1858, 36; 1859, 38; 1860, 37; 1861, 36; 1862, 40; 1863, 44. That is to say, in 1851 the twig put forth five leaves; in 1852, ten leaves, &c., &c.

It is worthy of remark here, that with every increase in the number of its absorbent surfaces or leaves, a young tree or branch must necessarily grow more rapidly. At any rate this law holds good up to the time when the tree begins to arrive at a maximum in its height and in the spread of its boughs; for till then the amount of leaf surface put forth in the atmosphere increases continually. When this period approaches, however, the vitality of the leaves put forth on the shoots at the extremities becomes enfeebled, and the shoots themselves become every year more and more circumscribed in their growth. The annual crop of leaves is now pretty much the same year after year. But the lofty tree, though it stands for hundreds and even thousands of years, has an appointed limit to its life, like the lowly flower that grows beneath its shade. Sooner or later it will begin to die at its extremities and decay in its interior, until at length the stem itself is merely a hollow living shell of wood, constituting the only bond of connection remaining between the roots and the branches which are still covered with verdure. As, however, branch after branch dies, the annual amount of its leafage necessarily diminishes. It is, however, extremely difficult to point out the several stages of stagnating and expiring growth, or to prove that a tree will ever die. In most cases death is brought about by violent interruptions to the natural life-processes. After having braved the storms of a thousand years, the tree is at last blown down and uprooted. Now busy, active, ever-industrious nature covers its fallen mouldering trunk with a shroud of moss and lichen, and there it lies in that forest grave-yard until it is again resolved in its original elements of earth and air.

The twig represented in the plate shows beautifully this gradual arrest of growth at its extremities, and also the diminution of annual produce in the foliage; thus illustrating clearly that law which governs the whole tree as it approaches the close of its allotted period of life. Let us confine our observations to the primary axis of our twig, which, with its little side-shoots, represents the massive stem and branches of the tree from which it was cut, on a smaller scale of architecture, being

precisely the same in anatomical construction and governed by the same laws.

The tree from which this twig was cut was one of the oldest in the forest, and must have been growing for several centuries; the twig itself had only been growing for thirteen years, yet a transverse section of the primary axis of the twig, if compared with a cross-section of the stem of the tree, would show, notwithstanding their difference in size, the same parts, the pith in the centre, a number of concentrical rings of wood, and the bark on the outside. But in the twig, there would be only thirteen rings of wood, in the stem of the tree several hundreds. For each tree, each twig carries in its interior the monumental history of its life, and exhibits in the cylindrical woody deposits of each vegetative season marks which are ineffaceable excepting from the influences of decay.

Between the years 1850 and 1859, or for the first nine years, the growth of the central axis was nineteen inches and four lines; also, in 1851, the primary axis, which was then without a single shoot, only produced itself five leaves; but, in 1859, it had put forth eleven shoots, all of which were in foliage, making the entire leaf crop thirty-eight, or an addition of thirty-three leaves to the annual produce in eight years. But the growth of the primary axis, between 1859 and 1863, was only two inches and seven lines, with an addition to the annnal leaf-crop of only six leaves, and this, too, in four years. Our twig was, therefore, cut when it was approaching the limit of its vegetative progress, for its growth annually was stagnating, as is evident from the approximation of the sets of annuli at its extremities, and the slower increase in the annual extension of its leaf surface.

An animal may continue to live after it ceases to grow, but it is not so with a tree or a twig. For a tree or a twig continues to grow as long as it lives, and when it ceases to grow it ceases to live. This gradual and continuous stagnation of growth at the extremities of our twig is, therefore, also indicative of the fact, that its vegetative force was gradually expiring, and also shows that its life was rapidly drawing to its close.

Once more, we have seen that fifty-four leaves were employed in constructing the primary axis, yet only fifteen of them produced buds which became branches; also, that these fifteen branches, although constructed by 299 leaves, developed only fourteen shoots; for, referring to the plate, the reader will find that the first side branch produced three; the second, nine; and the seventh, two shoots; it follows that of these 299 leaves only fourteen produced vitally active buds, and that the axilla of all the others remained unfruitful. Therefore, the total number of abortive or rudimentary buds in the entire twig must be $353 - (15+14) = 324$.

Some of these 324 buds have retained a sufficient amount of vitality to carry them forward through the annually deposited layers of wood and bark, so that they still continue to maintain their position, year after year, on the outside of the bark. Several of these buds are visible in our plate on the surface of the central axis of our twig, and also on that of its first and second side shoots, and more may be detected on the surface of the other shoots, if the plate be examined with a small magnifier.

For example, there is a rudimentary bud on the primary axis, just below the set of annuli, marked 52, on the left side of the twig, which was matured by a leaf which fluttered in the winds and was bathed in the showers of the spring and summer of 1851; that leaf fell from off the axis in autumn, and left that bud on its surface, which has just life enough left in it to enable it to keep on the outside; that bud has been in that torpid condition for twelve years. And the bud, just above it, on the same side, nearly opposite that curved shoot, which is so instructive, was matured in the autumn of 1852, and has, therefore, been torpid for eleven years.

In cases like these where a bud has been formed by a leaf which has died years ago, and has maintained its position on the outside, if a section be made at the point of the stem where it is seen to protrude, the vegetative course of the bud will be marked by a line of pith, which traverses the several layers from the centre outwards.

In other instances the abortive buds of our twig died and were detached from the shoot the first year, or they retained their life but continued totally inactive. In the latter case the abortive bud necessarily sank below the surface, and became buried beneath succeeding annual deposits of bark and wood.

The trunks and branches of trees always contain an immense number of these buried buds, which may remain for years entombed below their bark in a state of passive vitality, like a seed which is buried in the ground.

Leaving out of consideration the rudimentary buds visible to the eye unaided, or assisted by a magnifier, on the surface of our twig, and supposing one half of the rest to have died, it is probable, even then, that there are more than a hundred abortive buds or points of vegetation buried beneath the bark of this little twig, only 13 years old, and 20¼ inches in length! What, then, must be the immense number of abortive buds in powerful branches which have been growing for centuries, or in the stem of a tree built by the leaf-labour of a thousand years. The vitality of those buds is not destroyed. Their parent leaves, it may be, have died and dropped from the tree many, many years ago, but they still retain unimpaired the life which they then received. Let some of the leading

branches of the tree be broken off by the high winds of winter, and when spring comes they will attract the sap which went to those branches to themselves. This will arouse their dormant energies so powerfully that they will force their way through the wood and bark to the surface, though that wood may be the growth of years. The bud which has slept in a condition of feebleness, perhaps for half a century, will break forth at last into a powerful branch, the injury done by the hostile forces of nature will be repaired, and the tree will carry on successfully the battle for life.

All must be familiar with the sight of willows and other trees whose main branches have been thus broken off, and whose trunks are nevertheless covered with young branches and shoots, the growth of buds which have been buried in the wood and for years dormant beneath their surface.

We have thus, we hope, placed before the reader a simple and accurate method of studying the growth of trees. Of the tree it may be truly said that THE WHOLE IS REPRESENTED IN EACH OF ITS PARTS.

EXPLANATION OF PLATE XVIII.

Branch of Common Beech (*Fagus sylvatica*), showing its annual growths for thirteen years. The sets of annuli show the successive points where the growth was stopped during winter, and the figures opposite, the year when this occurrence took place.

REVIEWS.

COMPARATIVE PHYSIOLOGY.*

THE accomplished author of the *Souvenirs d'un Naturaliste* has produced under this title a very readable little book, which treats of one of the most complicated questions in physiology—that, namely, which has reference to the extraordinary variety of forms derivable from the same species among some of the lower animals, their mutual relation, and the analogies which may be discovered between them and some of the phenomena exhibited in the reproductive processes of the higher animals. There are few questions in the range of physiological inquiry which have raised greater feelings of wonder, or which have given rise to more speculation than those which have received the name of "alternate generation," "parthenogenesis," &c., while at the same time the obscurity and complexity of many of the phenomena have stimulated the curiosity of some, and deterred other investigators from entering upon a subject of so much difficulty.

M. de Quatrefages commences his work by pointing out that *change* is inherent in animal bodies, the highest no less than the lowest—plants and animals are momentarily losing some of their substance, which must be renewed; and this applies to all parts alike, the most delicate, and those which are most assimilated to inorganic bodies. He points out the defects in the general acceptation of the term *metamorphosis*, and proposes three expressions, each having a distinct meaning, to be applied to the very different forms of change which take place in various grades of the organic kingdom, viz., *transformation*, which includes the whole of the changes which a *germ* undergoes in its progress to the condition of an *embryo; metamorphosis* he retains to imply the changes which the animal undergoes after exclusion, and which profoundly alter the general forms, or the modes of life of the individual; while he proposes the new term *geneagenesis* for those changes which refer to the generations themselves—a term derived from γενεα, birth, and γενεσις, generation.

The transformations, then, which take place in the egg, or ovum, next occupy the attention, from the first appearance of organized tissue through all those remarkable stages which have of late years been so carefully and elaborately worked out and watched, more particularly by

* "The Metamorphoses of Man and of Animals," by A. DE QUATREFAGES. (Métamorphoses de l'Homme et des Animaux, par A. DE QUATREFAGES.) Paris: J. B. Baillière, 1862.

German physiologists. The author, in passing, pays a just tribute to the celebrated Schwann, whose theories, at one time almost universally accepted, have long since been found to be formed upon false premisses and imperfect observations. But, as he observes, like all general doctrines which bind together a great number of isolated facts, this cellular theory has at once cleared and widened the field of research. Transformation, however, in the form of growth, continues to take place in the higher animals after exclusion, but it is worthy of remark, that it is often of a kind which Milne Edwards designates as *recurrent development*, as in the case of the higher monkeys, which at birth not a little resemble man, but, from a certain moment, their development, instead of raising them, lowers them in the animal scale, making more and more wide the breach between them and the human species.

The *metamorphoses* of animals in their restricted sense are of course best illustrated by those which are exhibited in the class of insects, in which there is apparently a sudden change from the grub to the chrysalis; and from the chrysalis to the imago or perfect insect. But these changes are really very gradual, and the aphorism "*Natura nihil fit per saltum*," is fully borne out in their case. We have not space to follow our author through the interesting and lucid details which he gives concerning the metamorphoses of insects in general, of myriapods, crustacea, annelids, molluscs, reptiles, and batrachians, all of which exhibit features of striking and peculiar interest. Instead, however, of regarding the various forms presented by an insect, for example, in each of its metamorphoses, as distinct beings, of which the first inclosed and nourished the second, (as Réaumur would have done,) by the light of modern science we are enabled to perceive that they are but the same being in stages analogous to those presented to our notice by the embryo, the fœtus, and the young of mammiferous animals. And the very proof which Réaumur invoked in favour of his view, viz., the dissections of Swammerdam, who could distinguish in the advanced caterpillar the antennæ, wings, &c., of the perfect insect, shows the gradual and progressive nature of the change to which they are subject. The caterpillar for us is an embryo which, in order to become adult, has not only to grow, and to develop itself as an infant would, but also has to pass through certain changes analogous to the embryonic changes of higher animals. The rapidity of growth, too, which is so remarkable a character in the primary conditions of insects, is one which is eminently analogous to the embryonic condition; and thus a larva may be considered as an independently existing embryo, which nourishes *itself*, instead of being fed by its mother, and undergoes externally, before our eyes, changes or *transformations* analogous to those which, in the case of viviparous animals, are accomplished within the maternal organism.

The phenomena of the third kind, which are placed under the collective title of *geneagenesis*, dovetail, as it were, into the other two, as facts of progressive growth and individualization. Here we find animals which, rigorously speaking, appear to have neither father nor mother, but only *a parent*, which forms them at the expense of its own substance. We find, as it were, sons which never resemble their father, and which produce

children for ever different from themselves. We see a single germ produce not one individual, but multitudes of individuals, and sometimes several generations, which have no relation between them of form, structure, or mode of life. And, lastly, we see the germ lose its primitive individuality, and give place to a crowd of new individualities before the products of this very germ are arrived at the perfect condition.

The discoveries long since made by Peysonnel, Trembley, and others upon the generation of Hydra by means of gemmation and fission, and which caused at the time such universal interest, gave a great impulse to the early development of this question, and established the important fact that certain animals could, like plants, reproduce themselves by buds, appearing at first sight a deathblow to the doctrine of pre-existent germs. The succeeding great discovery, the origin of which is due to Chamisso, who announced in 1819 the alternations of generations of biphora (or salpæ), seemed as incredible as the adventures of Peter Schlemihl, his own "shadowless man." The new doctrine was first denied; then, when facts appeared too stubborn, attempts were made to explain them away; but the succeeding investigations of Sars and Von Siebold established incontestably the truth of these extraordinary disclosures of the secret workings of nature.

But the isolated observations of the first explorers of this new field were insufficient to give them any clue to the significance of these wonderful revelations. Modern science, however, has thrown much light upon the problem, and all these modes of generation are found to have something in common. In the case of the hydra, which reproduces itself by eggs, as well as by buds, it is as though there issued from the egg of a butterfly an animal having all the external character of the perfect insect, but deprived of organs of reproduction, which should produce by gemmation or budding beings like itself, and susceptible, as well as itself, of acquiring later the attributes of father and mother. In the case of the compound ascidians, it is as though the egg of the butterfly had produced first a caterpillar, and that this has arrived at its perfect condition; then, on this butterfly issuing from the primitive egg other butterflies like the first have made their way (*poussé*), of which the original one is, properly speaking, neither the father nor the mother, but only the *parent*.

Geneagenesis does not exhibit itself among true mollusca; but in the division of the *molluscoids* it appears to be the general rule. All these animals are more or less near in position to the biphoræ.

Among the echinodermata there appears to be a sort of connecting link between the two orders of facts above alluded to, and the gulf between the two is thus bridged. The whole animal comes under the category of geneagenesis; but many of the important internal organs undergo a simple metamorphosis. The doctrine of spontaneous generation, which has so often been bolstered up by the phenomena presented by the propagation of intestinal worms, can no longer resort to this support, since it is now found that the remarkable phenomena of alternate generation are exhibited in a strongly marked manner in this division of animals. All the pretended agamic species are now known to be only different phases of development of sexual species. These changes have, in many cases, been accurately followed, and analogy would justify us in believing that

the same obtains with the remainder. We can, with more and more certainty, echo the aphorism of Harvey, "*Omne vivum ex ovo.*" The phenomena of geneagenesis mask, but do not alter, the principle of this great truth. Buds are the products of pre-existing germs,—secondary germs, in fact; and a gemmiparous reproduction suffices not to perpetuate the species, for at the end of a certain time reproduction by an egg becomes absolutely necessary. This alone is a function of the first order, to which gemmation is only subordinate.

In the latter part of his work, M. de Quatrefages combats the opinion of Professor Owen, of whom he speaks with the greatest respect, on the subject of parthenogenesis, and offers his own views of these phenomena; pointing out that, like multiplication by buds, or by suckers, natural or artificial, or by alternate generation, all of which he believes to be manifestations of one and the same grand phenomenon, so also *parthenogenesis*, or virginal reproduction, is but a particular case of geneagenesis, and, therefore, comes in the same category as those before mentioned.

The work of M. de Quatrefages abounds with original views and clear expositions of complicated and obscure phenomena, which he has brought into an ingenious and useful connection. We look upon it as the best that has appeared upon the difficult subject of which it treats, and should like to see it laid before the public in an English dress.

The Tropical World: a popular Scientific Account of the Natural History of the Animal and Vegetable Kingdoms in the Equatorial Regions. By Dr. G. Hartwig, Author of "The Sea and its Living Wonders." London: Longman & Co., 1863.

THERE are, perhaps, few things which exercise so fascinating an influence upon the imagination of the student of natural history as the glowing descriptions given by travellers, of the aspects of nature in the tropical regions of the globe. Familiar as we all are with the moderate vegetation, with the sober tints of the birds and insects, and with the generally unimposing and harmless character of the quadrupeds and reptiles of our own temperate climes, the contemplation of the marvels of form, of size, of strength, and of colour, exhibited by the productions of the tropics, inspire us at once with admiration and with awe. Beautiful as are our leafy groves of oak and beech, resonant with the melodious voices of brown-coated birds, and tenanted by the stately forms of oxen or deer, they lack at once the grandeur and the grotesqueness of the strange and giant vegetation of the tropical forest; they lack the wondrous birds which, like living gems, dazzle the sight, as they flash through the sunshine, or settle in the shade; they lack the strange and unearthly sounds of the campanero, the howler, and the whip-poor-will, which seem to enhance the mystery of its gloomy recesses. Guided by the vivid descriptions of the veterans Humboldt and Waterton, we can picture to ourselves the pathless and interminable forests of Guiana, where Nature exuberates in perfect freedom from human interference—now revelling in dense and impene-

trable thickets, entwined with thorny shrubs and woody *lianes*—now opening into a sheltered pool, bosoming upon its waters the gorgeous Victoria water-lily;—and we feel as if we could almost hear the strange, wild, and mournful sounds produced by the inhabitants of this enchanted region. These are well described by the author:—

"Complete silence occurs only during very short intervals, for there is always some cause or other that prompts some animal to break the stillness. Sometimes the din grows so loud, that one might fancy a legion of evil spirits were celebrating their orgies in the darkness of the forest. The howling of the aluates, the whine of the little sapajous, the snarl of the douroucouli, the roaring of the jaguar, the grunt of the pecari, the cry of the sloth, and the shrill voices of birds, join in dreadful discord. Humboldt supposes the first cause of these tumults to be a conflict among animals, which, arising by chance, gradually swells to larger dimensions. The jaguar pursues a herd of pecaris or tapirs, which wildly break through the bushes; terrified by the noise, the monkeys howl, awakening parrots and toucans from their slumber, and thus the din spreads through the wood. A long time passes before the forest returns to its stillness. Towards the approach of day, the owls, the goatsuckers, the toads, the frogs, howl, groan, and croak for the last time; and as soon as the first beams of morning purple the sky, the shrill notes of the cicada mix with their expiring cries." (P. 84.)

We never tire of such scenes, and the mind feels an ardent desire to know more of these wonders. To few does the good fortune fall, of an opportunity of exploring for themselves such regions of marvels—to the many they are for ever the unapproachable fairy-land, which they were to our young imaginations. We therefore hail, with pleasure, the appearance of the goodly volume before us, which is devoted to the description of tropical nature, and affords a succinct, exhaustive, and accurate account of its leading animal, vegetable, and physical features.

Dr. Hartwig is already favourably known as the author of a work entitled "The Sea and its living Wonders," to which the present is in all respects a companion volume, of the same form and size, and with the same class and copiousness of illustration. Although these are often objectionably small, many of them are excellent, characteristic, and original, and greatly enhance the value of a work intended to convey useful information in a popular, but at the same time, scientific and accurate form. There are also eight principal illustrations, consisting of "chromo-xylographs" (which, being interpreted, signifies *tinted wood-cuts*), representing as many well-selected tropical scenes of striking interest. The plan of the work is threefold, the first giving an account of the general aspects (chiefly physical) of tropical nature; the second being descriptive of the wonders of tropical vegetation; and the remainder, or more than one-half the volume, is devoted to the varied and teeming insect and other animal life.

The aspects of tropical nature exhibit themselves under various forms, such as the thirsty Llanos, calcined grass-plains, presenting the monotonous aspect of interminable wastes, whose limits melt in the hazy distance with those of the horizon, and which in the dry, parched season sometimes catch fire, and are soon converted into a black and charred region of miles and miles in extent. But let the tropical rain fall upon this arid and

thirsty land, and vegetation springs up with almost miraculous rapidity, and "the dull tawny surface of the parched Savannah changes as if by magic into a carpet of the most lively green, enamelled with thousands of flowers of every colour." The Puna, or uninhabited region of high table-lands in Peru and Bolivia, though situated near the Llanos, in the torrid zone, yet being elevated from 10,000 to 14,000 feet above the sea, contrast with them in their bleak and unfriendly climate, constantly liable to wintry storms and sudden changes of temperature, as much as 45° in a few hours. In such unfriendly regions a few stunted shrubs and dense grass form the characteristic vegetation; and from these the useful llama and alpaca derive subsistence, the wool which protects them from the inclemency of the situation being one of their chief attractions. In Africa, the Kalahari and the Sahara—though both deserts—are not both equally inhospitable; for while Sahara, extending from the 39th to the 70th degree of N. latitude, is a dreary waste, redeemed only by bright green oases, which break its monotony, like the charming islands which stud the vast solitudes of the Pacific, the Kalahari is far from being destitute of animal and vegetable life. It contains but little water, but in no other respect can it be called desert, being covered with grass and creeping plants, while the Caffre water-melon covers the ground in some seasons with juicy gourds. Koodoos, gemsbocks, elands, and other antelopes may often be seen here forty miles from the nearest water; and other game, such as rhinoceri, buffalos, gnus, and giraffes are not unfrequent in its immediate neighbourhood. To each of these characteristic regions, as well as to the Peruvian sand-coast, the Mexican plateaux, the mighty Amazons, in the West, and the Sikkim slopes and mangrove swamps in the East, is an interesting chapter devoted in the work before us.

The characteristic forms of tropical vegetation consist of trees often of gigantic size, such as the baobab, or Adansonia, more than a hundred feet in circumference, though only about sixty feet high; great dragon trees (*Dracænas*), sycamores, and the widely-renowned banyan (*Ficus indica*), each tree a little grove, sending out in the case of a celebrated one on the banks of the Nerbuddah 3,000 root-trunks, still covering a space of ground 2,000 feet in circumference, and once known to have afforded shelter to 7,000 men. Often to beauty of foliage and majesty of form there is superadded a delicious aroma, as in the sandal-tree of the Malabar coast; or the attention is arrested by a strange grotesqueness of form, as in the giant cacti of the New World, some remarkable specimens of which are figured in Plate 4, rising in angular columns to the height of 60 feet, generally branchless, sometimes strangely ramified as candelabras, while others creep like ropes upon the ground, or hang snake-like from the trees. In similar situations to the last are "endless varieties of epiphytal plants of inconceivable size and luxuriance, such as ferns, bromelias, tillandsias, orchids, and pothos, covering the trunks and branches of the forest trees with hanging gardens far more splendid than those of ancient Babylon." But the palms must not be forgotten—the trees of all others the benefactors of man—whose three hundred and sixty uses have been sung by the Eastern poets. "Some years ago a ship from the Maldive Islands touched at Galle, which was entirely built, rigged, provisioned, and laden with the produce

of the cocoa-tree." Graceful in form, and fertile in valuable and useful products, many species may yet be considered to possess virtues which, at present undeveloped, may be destined to hold important rank in the future commercial annals of the world.

To the exuberant fertility of this zone *we* are also indebted for abundant vegetable nutritive products,—rice, maize, arrowroot, sugar, coffee, cocoa, &c.; important spices, as nutmeg, cinnamon, cloves, pepper, and ginger; dyes, as indigo and dyewoods; manufactures, as cotton, caoutchouc, and gutta percha—all indispensable adjuncts to civilization, all demanding the heat and the light which the tropics alone can afford, and all finding a place in the volume before us.

But the tropics, rich and fertile as they are, attractive enough to cause a mutiny of the "Bounty," are not without their drawbacks, and the worst of these are, perhaps, to be found in the insect world. Mosquitoes in clouds, protected by their numbers and their minuteness, "murder sleep." Chegoes, or jiggers, insinuate their nests into the feet and toes, and, if allowed to remain, cause their victims to be "lamed for life, and become loathsome to the sight;" blood-sucking ticks and *bête-rouges* produce painful sores on the undefended parts of man; while the tzsetse-fly, or zimb, is the scourge of cattle, so terrible and so fatal, that "had any one of our indigenous flies similar poisonous qualities, we should never have been able to escape from barbarism." Locusts and cockroaches are ever ready to devour everything, and are, in their way, no less important plagues. Against these we may place the silkworm and cochineal insects as absolutely invaluable, and a host of others are at once harmless to man and marvellous in their form, size, or habits. Gigantic beetles, the elephant, typhon, hector, and goliath, fighting mantises, leaf and walking-stick insects—those singular freaks of Nature, bright lantern-flies, and luminous beetles are among these. Ants and termites as wonderful as our own bees, if not more so, from their wondrous societies, unwearied industry, and astonishing intelligence, are inexhaustible sources of interest; and though some are formidably armed and dangerous neighbours, they are not without their uses. The ranger-ants of West Indies sting cruelly, but their appearance is the death-warrant for every spider, scorpion, cock-roach, or reptile that pollutes the dwelling.

The dangers arising from the bite of venomous serpents appear not to be so great as is generally imagined. Sir E. Tennent frequently performed journeys of two to five hundred miles through the jungle in Ceylon without seeing a single snake. They are easily alarmed, and hastily retreat, and only when suddenly surprised do they wound, and then in self-defence. Add to this, that but a small minority of snakes are poisonous, twenty-one out of ninety-one in tropical America, seven out of forty-three in India, and four out of twenty in Ceylon, and it is evident that the terrors of the serpent kind are usually somewhat exaggerated. Still the cobra, the bushmaster, and the rattlesnake are sufficient to strike terror into the boldest heart, and for these the whole race must be proscribed.

We must pass over the wonders of tropical bird-life, the painted toucans, the gemmed humming-birds, the military-looking flamingoes, the grotesque hornbills, the golden honey-eaters, the great soaring condors, and the

greater running ostriches, the noisy parrots and macaws, and the delicate-plumaged cockatoos, and devote the remainder of this notice to one or two of the characteristic mammalia of tropical regions. Here we have adventures by flood and field, in the chase of the ungainly hippopotamus, the savage rhinoceros, and the massive elephant. In the hippopotamus we should hardly expect to recognise much intelligence, or to credit much of the god-like attribute of memory; but he seems to have both where they may serve his purpose, or help to self-preservation. "It knows how to avoid pitfalls, and has so good a memory that when it has once heard a ball whiz about its ears, it never after ceases to be cautious and wide awake at the approach of danger." (P. 435.) Like elephants, certain solitary individuals appear to have a special bump of mischief, and are called *rogues* for their cunning and instinct for its gratification.

The account of the lion is specially interesting in connection with the paper by M. Jules Gérard, in the present number of this Review. "Man," says Dr. Hartwig, "judging from outward appearances and attributing to external beauty analogous qualities of mind, has endowed the lion with a nobility of character which he really does not possess; for modern travellers who have had occasion to observe him in his native wilds, far from awarding him the praise of chivalrous generosity and noble daring, rather describe him as a mean-spirited robber, prowling about at night time, in order to surprise a weaker prey." We will conclude our notice of this most interesting and instructive volume with a passage which places the moral character of the lion--if we may so describe it—in a somewhat novel light.

"When, so say the Bedouins, a single man meeting with a lion is possessed of an undaunted heart, he advances towards the monster brandishing his sword, or flourishing his rifle high in the air, and taking good care not to strike or shoot, contents himself with pouring forth a torrent of abuse:—'Oh thou mean-spirited thief! thou pitiful waylayer! thou son of one that never ventured to say *no!* think'st thou I fear thee? Know'st thou whose son I am? Arise, and let me pass!' The lion waits till the man approaches quite near to him; then he retires, but soon stretches himself once more across the path, and thus by many a repeated trial puts the courage of the wanderer to the test. All the time the movements of the lion are attended with a dreadful noise: he breaks numberless branches with his tail; he roars, he growls; like the cat with the mouse, he plays with the object of his repeated and singular attacks, keeping him perpetually suspended between hope and fear. If the man engaged in this combat keeps up his courage,—if, as the Arabs express it, *he holds fast his soul*,—then the brute at last quits him, and seeks some other prey. But if the lion perceives that he has to do with an opponent whose courage falters, whose voice trembles, who does not venture to utter a menace, then, to terrify him still more, he redoubles the described manœuvres, he approaches his victim, pushes him from the path, then leaves him, and approaches him again, and enjoys the agony of the wretch, until at last he tears him to pieces." (P. 468.)

THE CHANNEL ISLANDS.*

THE Channel Islands have deservedly "won golden opinions from all sorts of people," who have had the good fortune to make their acquaintance. Among them there is delightful boating, unrivalled sea-fishing, a genial climate, and plenty of scope for "pic-nicing" and sea-shore rambles. There is abundant employment, too, for the naturalist, the artist, and the antiquarian; and there is much to interest the student of men and manners,—much in the current customs of the islands which appears to us quaint and antiquated, being, in fact, lingering relics of the Mediæval period.

It is true that the scenery of these islands is nowhere on a very grand scale, but it is always pleasing, and often highly picturesque and impressive. The highest point of Sark—the wildest of the group—is only 365 feet above the sea-level; but the imposing effect of its scenery is out of all proportion to its really trifling dimensions. Each island has its own peculiar character more distinctly marked than one would suppose likely in a group so nearly associated. The coast-line is very diversified, sometimes showing gently-sloping sandy beaches of considerable extent, at others forming secluded little bays, each with its narrow strip of silvery sand, enclosed by walls of rock which rise steeply in the most picturesque variety of form, richly dyed with lichens and mosses, and washed by a sea most "deeply, darkly, beautifully blue." We cannot call to mind a more lovely example of this kind of scenery than the well-known Moulin Huet Bay, in Guernsey. The south of Guernsey and north of Jersey afford many scenes of this class—beautiful nooks, which once seen, cannot fail often afterwards to "flash upon that inward eye which is the bliss of solitude." Of a totally different character is St. Ouen's Bay, in Jersey, the noblest of all the bays of the Channel Islands, bounded by a range of sand-hills, from which the loose sand has been swept in eastward, converting a large tract of country into one great desert. Respecting this singular district, Mr. Ansted says:—

"Owing to the prevalence of westerly winds, the sands covering the wide flat of St. Ouen's Bay—the largest expanse of unbroken sand in the Channel Islands—are blown steadily onwards, and have at length not only covered the low hills near the shore, but have risen to, and partially overwhelmed the table-land of the interior. It is extremely interesting to watch this almost African expanse of undulating sands from the coast, in windy weather. The horizon is lost in the misty air, loaded with fine particles of sand, constantly in motion, whether the gale comes from the west or from the east. Since, however, winds from the former quarter

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* *The Channel Islands.* By DAVID THOMAS ANSTED, M.A., F.R.S., &c., and ROBERT GORDON LATHAM, M.A., M.D., F.R.S., &c.; with illustrations drawn by Paul J. Naftel, Member of the London Society of Painters in Water Colours. London: W. H. Allen & Co.

are both more frequent, and blow steadily up a continuous slope from the sea, while the latter are little felt near the lower ground, the ridge of the hill serving as a shelter, the result is an unmistakeable advance inland, and farms, houses, and even villages, become gradually obliterated. Much grass, of that peculiar kind that roots in loose sand, has been allowed to grow, but it is quite insufficient to check the evil."

We must not, however, dwell longer on the scenic attractions of the Channel Islands, our object being to notice, in connection with the work whose title is appended to this paper, some of those features which possess special interest for the naturalist. We have been fortunate enough to have spent two very delightful summer holidays in investigating several branches of their natural history, and can cordially recommend any brother naturalist to whom the islands are unknown, to go and do likewise. Whatever branch of science occupies his attention, he may be pretty sure of finding abundant material for study. The islands are, moreover, very easy of access, and the expense of living, though not so exceptionally small, as in the good old times, when tourists were few and far between, is, at any rate, very much less than at most sea-side resorts.

It is interesting to note that the most picturesque and characteristic scenery of the Channel Islands—the caverns, detached pinnacles, and "creux," are at once the result and the evidence of a constantly progressive destruction. Professor Ansted thus sums up the conditions under which these results are produced :—

"Nowhere on our shores is the tidal wave so powerful, nowhere are the storm waves so frequent; nowhere is there a coast consisting of material in which so much rock of extreme hardness is penetrated so thoroughly with veins of softer material. The very hardness of the granite, where it is hard, produces an unusual destruction of the softer veins ; for, as already explained, every fragment removed becomes a hammer, helping to undermine what is left. Whenever one hard mass is thrown down and broken up, another is soon attacked ; and thus a perpetual and rapid destruction is caused, increasing constantly in area, and not diminishing in intensity."

This destruction goes on so rapidly as materially to alter the rock surfaces in a very short lapse of time ; and it is certain that in historic times the general aspect and contour of the islands must have undergone very material change. Nor is this the only actively destructive agent. Earthquakes have been frequently felt, and even so lately as 1843 and 1853 shocks so violent as to cause great alarm have occurred.

The tides in the Channel Islands are the perplexity of dredgers, and add much by their violence and variable direction to the dangers of the coast. On this account, indeed, it is quite unsafe to venture on dredging or any other kind of boating without the help of experienced sailors. In many places the rush of the tide is tremendous. Through the narrow channel, for instance, between Sark and the Gouliot Rock, it sets with the impetuosity of a great river in flood ; and we well remember that in passing through with a fresh breeze and all sail set, it was all our boat could do to make head against the stream. A most beautiful and accurate view of this spot is given by Mr. Naftel at page 81. The complicated character of the tides will be understood from the following remarks :—

"The course of the tidal wave through the waters that surround the Channel Islands may be thus stated. The great wave coming in from the Atlantic advances from the south-west, and is turned to the east. A part of it passes on to the north-east, north of the islands; but a part enters among them by various channels, and being first lifted by shoal water, and then thrown back by the coast of Normandy, it is both detained in its course, and is deflected to the north. At Mont St. Michel the magnitude of the wave is at its maximum. Owing to the vast extent of the shallow water, and the narrowness of the deeper passages throughout the great bay enclosing the islands, the wave remains extremely large, amounting in Jersey to nearly forty feet, in Guernsey to almost thirty. . . . . The velocity of the tidal current, where not increased by narrow passages, is from two and a-half to three miles per hour. Although the course of the tidal wave may be thus traced, the current by no means follows the same law. In this respect the complication is so great that it would be quite impossible to describe it in this place; but, in a general way, it may be stated that the stream does not flow northwards with the advancing tide wave in the open channels till the wave has been flowing three hours, and that when it has turned it continues in that direction not only till the flood has turned, but till the retiring wave has receded half its course. In other words, the stream flows from half flood to half ebb, and ebbs from half ebb to half flood. While, however, this is the case in certain channels, the direction of the stream is not only different, but often diametrically opposite, at no great distance, but somewhat nearer shore."*

A visitor to Guernsey cannot fail to be struck with the great luxuriance of vegetation, especially of exotic forms. Plants which in England we are accustomed to regard as delicate or half-hardy, there thrive wonderfully, without any extraordinary care being bestowed upon them, even in winter. Hydrangeas and fuschias are particularly abundant, adorning almost every cottage garden with masses of bloom, which would be the pride of many an English conservatory. Fuschias attain the height of fifteen or twenty feet, and are rather trees than shrubs. The splendid Mexican aloe, *Agave Americana*, grows freely, sending up its gorgeous flower-stalks thirty or forty feet high. Yuccas, the *Camellia japonica*, and numerous exotic bulbous plants flourish in the open air. The well-known Guernsey lily is an example of the latter class; and, says Professor Ansted, "the great beauty of the rich red flower of this lily, and the fact that it flowers regularly once in two or three years in the island, while it can seldom be made to flower a second time in England, are subjects of great pride to the islanders." Nor is this richness of vegetation confined to cultivated plants: the indigenous flora affords many illustrations of the great geniality of the climate. Fronds of the sea, spleenwort (*Asplenium marinum*), have been gathered three feet in length;† and in every lane

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* "Between Guernsey and the Casquets the current sets from every point of the compass during each advance and recession of the tidal wave; hence the navigation is exceedingly difficult and dangerous in foggy weather, ships being sometimes drifted miles out of their course."

† In the South Isles of Arran, Galway Bay, we have gathered fronds of this plant of a similar size, and *Adiantum capillus veneris* nearly as large. The two ferns grew together in perpendicular rock fissures on the beach, and, whatever the depth of the fissure, they sent up their fronds to the level, or

some of the commoner ferns, such as *Asplenium adiantum-nigrum*, and *Scolopendrium vulgare*, are to be found growing in the greatest luxuriance. Guernsey exhibits this richness of vegetation in a much greater degree than any of the other islands; the reason being that its more seaward situation brings it more decidedly under the warming influence of the gulf stream, at the same time removing it further from the disturbing influence which the proximity of a great continent must to some extent produce. The tables of temperature given in the work before us exhibit very clearly the remarkable equability of climate enjoyed by the Channel Islands, and by Guernsey more particularly. For details we must refer the reader to the work itself; but the following table will show at a glance sufficient reason for this remarkable luxuriance of vegetation :—

	Greenwich.	Guernsey.
Mean temperature of		
Spring months (March, April, May) . .	46·9°	47·7°
Summer months (June, July, August) . .	60·6°	59·9°
Autumn months (Sept., Oct., Nov.) . .	49·9°	53·8°
Winter months (Dec., Jan., Feb.) . . .	38·2°	44·2°

The lists of the flora and fauna given by Mr. Ansted, though the work of many able hands, are confessedly incomplete, excepting those of the flowering plants and ferns, which are all based upon Mr. Babington's "Primitiæ Floræ Sarnicæ." The catalogue of seaweeds includes two hundred and twenty-two species,—an extensive list, the whole number of recorded British species being about three hundred and ninety. The islet of Herm is not represented in this list, and from our own gatherings there we can add the following species :—*Callithamnion floridulum* (very abundant), *Cladophora diffusa*, and *C. gracilis*, *Elachistea pulvinata* and *E. scutulata*, *Leathesia tuberiformis*, *Melobesia calcarea*, *M. lichenoides*, &c., *Mesogloia virescens*, and several others. It is worthy of notice, however, that the red algæ in Herm are mostly very poor in colour, owing to the deficiency of shelter from sunlight: they are more frequently yellow or green than red, except on the east coast, where the rocks offer more shade. The lists of Crustacea, both stalk-eyed and sessile-eyed, are also very imperfect. Amongst the former, for example, of the genus *Pagurus*, only two species are given: in addition to these we may name *P. lævis*, *Hyndmanni*, *cuanensis*, and *ferruginens*. But, notwithstanding unavoidable imperfections of this kind, the lists are very valuable as an attempt to illustrate thoroughly the botany and zoology of the islands, and will form an admirable nucleus around which the discoveries of other observers may be gathered.

We have already noticed the peculiarities of the Channel Island scenery, and have not space for more than the following short extract,

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nearly to the level, of the surrounding rock. A more favourable condition for fern growth it is impossible to conceive; the successive growth and decay of the leaves producing a constantly accumulating rich and loose soil, while the sides of the rock crevices afforded abundant shelter.

descriptive of the celebrated Gouliot Caverns in Sark, which may well be called the El Dorado of the British naturalists:—

"The first cavern is of noble proportions, and the floor is roughly piled with immense boulders, giving many and varied views of the small but picturesque 'Havre Gosselin,' seen through the opening at the further extremity. But this cavern, though fine, is, as it were, a mere outer court, preparing us for the glories to be revealed within. Its walls are partly covered with those singular currant-jelly-like animals one sees expanded like living flowers in marine aquaria; deep blood-red is the prevailing colour, but dark olive-green varieties are also common, and numerous yellow and brick-red patches are seen at intervals. A few mussels and tens of thousands of limpets and barnacles cover the boulders. Abundance of life is seen, and some of the specimens are as rare as they are beautiful. A branch of the first cavern, in which is a deep pool of water, conducts to the sea; but it is better to wait till low water and creep round outside. We then enter a gloomy series of vaults, lighted from the sea, and communicating with each other by natural passages. Every square inch of the surface is covered with living zoophytes; and in some parts an infinite number of *Tubulariæ* are seen occupying the walls."

The work from which we have extracted is edited jointly by Messrs. Ansted and Latham, the former having contributed the sections embracing Natural History and Physical Geography, as well as the Economics and Trade of the Islands; the latter being author of the chapters on Civil History and Antiquities. That the whole has been admirably performed cannot admit of doubt. The volume is beautifully printed, and contains numerous illustrations of scenery by Mr. P. J. Naftel. These are most artistically executed, and are faithful as well as pictorial: we know no other engravings which so agreeably reproduce the character of the Channel Island scenery.

THE ORIGIN OF SPECIES.*

(MR. DARWIN AND HIS COMMENTATORS.)

THE minds of men are so variously constituted that the observation of one and the same phenomenon often produces upon different individuals totally distinct and opposite impressions.

As in the tale of the travellers and the chameleon, one person examines an object from one position, and declares it to be white; another views it from a different stand-point, and unhesitatingly affirms that it is black; whilst a third, approaching it from the quarter where the two effects neutralize one another, pronounces it to be both, or neither, and at length discovers that it is grey; and he at once proceeds to enlighten the disputants.

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* Professor Huxley's Lectures to Working Men on "Our Knowledge of the Causes of the Phenomena of Organic Nature." R. Hardwicke.

Are we correct (we would inquire of the thoughtful reader), when we say that the debated controversy of the "Origin of Species" has assumed somewhat of this aspect to one who belongs to neither rank of controversialists?

Leaving out of consideration a host of writers, who have dealt with the subject without understanding anything of its merits, or who have formed hasty or prejudiced conclusions in regard to it, we still find many illustrious names rendered still more prominent by their association with that greatest of all nature's problems—the creation, modification, and continued existence of living forms; and where the leading naturalists of the age are found to hold diametrically opposite views, we can take but little credit to ourselves for having exercised caution in the expression of our own opinions.

But those who have followed us in our labours will be aware that we have done more than to exercise self-control; we have often (no doubt to the dissatisfaction of our correspondents) toned down, or entirely expunged statements which assumed as undeniable facts what many unprejudiced observers still regard as not proven, or even reject as error; and this we have done in order that a hasty expression of opinion on the one side might not call forth an acrimonious retort from the other.

The result has been that these pages are the neutral ground upon which men and women holding every phase of theological and political belief have met without restraint, and have learned to respect one another as searchers after truth. And it is chiefly with a view to maintain this prestige that we now venture to approach a question which will not allow itself to be cast aside; and upon which it is, therefore, right that each and all of us should bring our best judgment to bear.

During the brief period of the existence of this Periodical, we have had occasion to notice three works bearing upon the subject of the "Past and Present Conditions of Organic Nature;"* all written by authors whose names are more or less intimately associated with the controversy; and now there lies before us a fourth treatise, an unpretending little volume, so far as outward appearance goes, and comprising only 157 small widely printed pages of matter. But this little work, diminutive though it be in its proportions, contains the deliberately expressed convictions of a naturalist who is invested with great authority by virtue of his official appointments in the educational departments of the State; and whose careful and untiring research gives weight to any opinions that he may think fit to express in public on those subjects which (to confine ourselves for the present to an expression of his own) tend to "the improvement of man's estate, and the widening of his knowledge."

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* "The Past and Present Life of the Globe." By D. Page. Blackwood. (No. 1, "Popular Science Review.") "Unité de l'Espèce Humaine" (Unity of the Human Species). By De Quatrefages. Hachette, Paris. (No. 2, "Popular Science Review.") "On the Fertilisation of Orchids." By Charles Darwin, author of the "Origin of Species." Murray. (No. 5, "Popular Science Review.")

It deals with "the past and present condition of organic nature;" with the method by which the causes of these conditions of nature are to be discovered; the origin and perpetuation of living beings, and the phenomena that accompany these. It further enters into a critical examination of Mr. Darwin's book on the origin of species, suggesting to its readers how far they should be guided by the theories and hypotheses which it contains; and lastly, what is to us by far its most important feature, it is itself a verbatim report of a course of lectures delivered by the author (we believe in his public and official capacity) to the working classes of the great metropolis.

Our readers will therefore perceive that we are not called upon to deal with a mere scientific inquiry or criticism, of whose value every one may form a more or less accurate estimate, but that the doctrines and conclusions of the author will be taken for granted by, and serve as a guide to many who were previously unacquainted with the subject except by hearsay; whilst others more enlightened, perhaps, but still to a great extent strangers and new-comers in the world of science, will carefully scan its contents *as the popular exposition of the great scientific movement of the day;* and such persons will naturally form from its contents what appears to them to be the most accurate estimate of the efforts of modern science as applied to the laws of nature, as well as of the opinions held by scientific men.

The avowed purpose of the present work is, as already stated, to communicate to the partially educated masses what appears to the author to be a faithful account of Mr. Darwin's views concerning the origin of species, and to convey his (the author's) unbiassed opinion as to how far these views are entitled to their acceptance.

With this object, it may readily be supposed, that the author would find it necessary to impart to his readers some knowledge regarding the past and present condition of organic nature; and, considering the disparity which exists between him and his readers in extent of knowledge and modes of thought, it would have been impossible for him to have performed this portion of his task more efficiently than he has done. Indeed, there is no need for any qualification in our approval; and we are only doing him justice when we say that the combination of popular phraseology with accurate scientific information has never been surpassed, perhaps not equalled in any similar course of scientific lectures of a popular character that has come under our notice.

The mode in which the reader (or hearer) is enabled to carry away with him a simple, yet accurate ideal of the animal frame; and the familiar similes whereby the functions of the living creature are impressed upon the mind are above all praise. In fact, whenever the author attempts to convey to his imperfectly educated hearers (we speak, of course, of their scientific education only) a knowledge of those phenomena in nature which are recognized as *facts*, he does so with admirable tact, and in nearly every case with undeniable accuracy.

Had he confined his labours within these limits, and simply proposed to himself to make his readers and hearers acquainted with the phenomena of nature as they *are*, our criticism would have ended here;

but unfortunately he has not done so; and as his fame and position preclude our passing over the inaccuracies in his work with a brief comment or laying it aside altogether, we have no other alternative than to deal with its defects as with its merits. This we will endeavour to do as fairly as we are able, not confining ourselves to a mere expression of opinion as to what appears to us inaccurate or inconsistent, but endeavouring to point out where the error lies, and where the argument yields under investigation.

It would be almost impossible, in this criticism, to sever the author's views concerning the laws of nature from those of Mr. Darwin. Not that we consider them identical, but the author seems to believe that they are, and would have us think the same; so he has written his book accordingly.

To some extent, no doubt, their views are identical, and in one important particular they may be considered completely to coincide. Both believe that the formation of a new species in nature is the result of the gradual modification of some other species (that each is not a special creation); and that the operating cause is the conjoint action of what the author calls "atavism* and variability," and the various conditions of existence in which the animals are placed; in fact, they believe that the production of *varieties* and the perpetuation of *races* are due to inherent tendencies or properties possessed by the animals themselves, and by the external conditions by which they are surrounded; and then extending this principle further, they believe in the formation, by this mode, of *species*, *genera*, &c.

This is the doctrine of Mr. Darwin. But our author is not content to be a teacher, a mere repeater of the theory of another: he takes upon himself the duty of a guide and critic, and tells us that, before we accept any new theory of this kind, we ought to subject it to the most searching scrutiny; thus constituting himself our guide, he proceeds to lead us accordingly.

We should not, he says, reject this or any other hypothesis merely because we are told that it is not in accordance with the Baconian philosophy, but we should deal with it as we would treat any question in common life. To enable us to do this, he gives, in one portion of his work, numerous illustrations of the kind of treatment of which subjects of this kind are susceptible, selecting one example in particular that appears to him to be peculiarly applicable to the solution of the problem connected with the production of a new species; and in a later discourse, he lays down with more precision the rules by which, according to his views, the accuracy of Mr. Darwin's hypothesis should be tested.

"The method of scientific investigation," he tells us, "is nothing but the expression of the necessary mode of working of the human mind;" and, as an incident taken from common life, illustrative of the method by which phenomena may be attributed to their true causes, he mentions the case of a man who, having left some plate in his parlour over night, comes down the next morning and misses it. Seeing

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* Hereditary similitude, from *atavus* (ancestor).

that the window is open, he inspects it, and finds the mark of a dirty hand on the window-frame, and subsequently the impress of a hob-nailed boot outside on the gravel. Of course, he suspects that his plate has been stolen, and the *hypothesis* is that the owner of the dirty hand and hob-nailed boot is the thief. Undeterred by the counter-hypothesis of some kind friend, who suggests the possibility of the laws of nature having been "suspended during the night," and that there might have been "some supernatural interference in the case," he calls in the aid of the police, who track the burglar with the property on his person, and find that the marks correspond with his hands and boots. Under such circumstances, he thinks a jury would verify the hypothesis by convicting the prisoner.

After showing that it was by such hypotheses that Newton and Laplace made their discoveries, and telling his readers that the value of the result of the hypothesis depends upon the pains taken in its verification, he proceeds to say that it is on this inductive method of inquiry he means to consider the state of "our present knowledge of the nature of the processes which have resulted in the present condition of organic nature."

The precise bearing of this anecdote to the point at issue is not given with the story itself, and we shall inquire how far it is applicable to the natural problem before us; supplying what appear to us to be deficiencies, which might not occur to the "working classes."*

The Story :—

1. A gentleman misses his plate, and asks himself what has become of it.
2. He finds evidence of a man having escaped from the window.
3. From this evidence he concludes, or rather forms the hypothesis, that a burglar had stolen his plate, and has escaped from the window; and determined to be guided by this hypothesis, he directs his investigations accordingly.
4. On proceeding in his investigations, he finds the burglar with the property on his person, and has him convicted.

The Moral :—

1. A naturalist observes that certain groups called species are related together by structural and functional peculiarities; and he asks himself how these species have originated.
2. He finds that by artificial breeding or selection, man is able to form varieties and races; and that similar influences to that exercised by man are all at work in nature.
3. He conceives the idea of natural selection; and assumes that "species" have thus originated.
4. *To be complete, the moral should conclude thus :*—He investigates the operations of nature; finds species formed by natural selection; and thus realizing his hypothesis, he arrives at a satisfactory solution of his problem.

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* At p. 137, the author specially refers to this anecdote as constituting a case analogous to the one at issue, namely, the causes of origin of new species.

This we presume should be the *rationale* of the story; but is it so?

It is very easy to frame a suppositional argument, carry it to a satisfactory conclusion, and leave the reader to infer that it is precisely analogous to another that is hypothetical; but the author cannot be surprised if his readers, finding that his analogy does not hold good, should throw away his whole *theory* as worthless; and we fear that with many it will be so in the present instance. We have no objection to handle the inquiry after the author's own approved fashion; but we trust he will not object to the introduction of a little fresh evidence and one or two additional witnesses. As it is a serious case, too, and affects the liberty of the subject (for he sentences his man), we hope he will allow us to employ counsel, on our granting him the same privilege. We, too, shall put an hypothesis.

His "objector," who happens to visit him in his trouble, endeavours to dissuade him from calling in the assistance of the police, and does so on the ground that as the spoons were taken away at night, the possibility is that the laws of nature might have been suspended at this season and that there may have been some supernatural interference in the case, into which it would be presumptuous in the owner of the spoons to inquire.

We presume that this means, that as species originated before man appeared on earth, or before the beginning of the historic record, therefore, it is possible that the laws of nature were different then to what they now are; that species were supernaturally created; and it would be presumptuous in us to inquire into their origin.

We will now introduce another witness and a fresh element into the inquiry, the nature of which will be fully comprehended from what follows.

Another friend who happens to enter the room just as the owner of the stolen spoons has pushed his first friend aside, and is about to depart in search of the police, and hears what has happened, stops his exit, and says, "Softly, my friend; I don't put so much faith in the reversal of the order of nature as does your friend there; but don't be hasty: you are very much agitated in consequence of your loss; and, perhaps whilst you are running off in search of the police, the thief may be down stairs cleaning your boots, and he or she may take the opportunity to secrete the plate. Just let me see the marks on the window." And it is possible that when he comes to the window, his friend might say, "My good fellow, I always knew you to be an excellent leaper; but you seem to think there are better than yourself in the world; for this window is at least thirty feet from the ground, and if the thief did not fall into the area and break his neck, he would certainly be impaled upon the spiked railings beyond. Have you ever tried the experiment yourself?" Now we can imagine our friend of the stolen plate a little puzzled at first, but replying with great confidence: "Well, not exactly; but it occurs to me that a friend of mine, a much more active man than I am, once tried to get down into the garden, and he succeeded after endless labour and risk in reaching that ledge which projects from the wall about half way down. He came up again and expressed his conviction that the remainder of the descent was feasible also,—and so with your permission I shall go for the police." Well, we may tell our readers frankly that we think this

person was very hasty, and would have done better if he had looked about in his own house, and had sent the most trusty of his servants to seek the police at the same time. We apprehend that if he found a burglar, or a man of notoriously bad character, with the plate upon him, there could be no doubt as to who was the thief, without either the evidence of the dirty hands or footmarks in the garden; but thieves do not generally carry stolen property about with them, especially when it is as heavy as silver plate is usually supposed to be; and we must beg our author to let us presume that the plate was discovered at a pawnbroker's, and that a man with dirty hands and hob-nailed boots was found, whom the pawnbroker believed to be the person that pawned the plate. Now we anticipate that the jury would like to be satisfied—

1st. As to whether this was the man who left his marks on the window.

2nd. Whether the pawnbroker was correct as to the identity of the thief.

For it is just possible that the actual thief may still have been in the house, and may have employed him of the dirty hands and hob-nailed boots to pawn the property for him.

Let us follow the owner of the property. We suppose that although he might think the evidence perfectly clear, he would entrust his case to counsel, and the professional gentleman, not being the victim of the theft, would naturally inquire into all the circumstances, and, amongst others, would hear of the height of the window from the ground; so, too, would the counsel for the defence. But, as our readers know, it is the duty of a barrister to make out his case, and upon his ability to do so under difficulties depends the success of his client. Well, we can imagine the prosecuting counsel being very much puzzled to connect the marks left by the man with the man himself, and endeavouring to get over the difficulty by some such pleading as this: —

"Every portion of the evidence, gentlemen, is quite clear, excepting one link; and this there is good reason to believe is much more tenable than it appears, for a friend of my client once succeeded, though with some difficulty, in getting upon the ledge half-way down, and he has been consulted, and repeats what he said at the time of his experiment, *viz.*, that he is satisfied the thing could be accomplished. My client, who is a clever gymnast himself, thinks the same. And I defy my learned friend, the counsel for the prisoner, to show that it was impossible for the prisoner to have effected his escape to the ledge, and from the ledge to the ground. *We* don't pretend to explain *how* it can be done, but we see every reason to believe that it is possible, and unless my learned friend can prove the contrary, I argue that the *jury* has no other alternative than *to commit the prisoner!*"

Now it appears to us that the best course for the defending counsel to adopt would be to leave the evidence precisely where it stands; and not even to avail himself of the arguments used by the objector on the ground of "supernatural interference," in the hope that some of the jury might be "orthodox;" for we have little doubt that the prisoner would be

acquitted without much consultation on the part of the jury,—in fact, the verdict would be "Not proven."

This, as it appears to us, is precisely how the question of the "Origin of Species" stands at present. The chief obstacle which now stands in the way of the acceptance of Mr. Darwin's theory is, that he has not been able to create a new species by artificial selection. Although he has effected in a few years an approach to that end which, *in nature*, would probably have occupied ages; and although he and others have produced 150 varieties (of pigeons), differing widely from one another, yet in every case these varieties have been fertile with one another, and there has been no approach to sterility.* Neither can it be shown that "*natural* selection" is anything more than a probability, nor that, in nature, species have been found to cross, excepting (as a general rule) with sterile results.

This is of course the chief interpretation of our supplementary evidence concerning the height of the window from the garden. And now as regards our author's special pleading. If any one thinks that we have overstated or burlesqued this part of the subject, let him turn to the text,† and there he will find how ingeniously, nay, how plausibly, the author disposes of the difficulty in question, really the crucial test.

The author's argument is practically as follows. We will test the validity of Mr. Darwin's theory by a three-fold process:—

1st. We will ask: Do the supposed *causes* of the phenomena exist in nature?

The answer is decidedly affirmative. Atavism, variability, and conditions of existence analogous to those which are operative in artificial breeding, *do* exist in nature.

2nd. Are these causes competent to produce new *species*?

Answer, not quite so confident. *Races* may be thus produced, and it would be very difficult to explain many of the phenomena connected with species in any other manner.

(Is it possible to reach the ground from this window?

Yes; a friend of mine has succeeded in reaching the projecting ledge; besides, there are many circumstances connected with the theft—dirty hands, &c., which could not be otherwise explained.)

But I grant freely that, so far, it has been found impossible to produce infertile hybrids by artificial breeding, and being a *disinterested critic*, I feel bound to confess that it is a serious barrier to the acceptance of the views which I advocate. Still the phenomena of sterility are very capricious. The crucial test *may* be successfully applied, and unless *you* can prove it to be *impossible* you have no right to say it cannot be effected, and to deny the accuracy of my theory, which assumes that this is the normal method by which new species have been produced.

(There is no knowing whether some day or other a person may not manage the leap from the ledge to the ground; and unless *you* can prove that it is an absolute impossibility, you have no right to say that my

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* This will be more fully explained hereafter. † P. 137.

plate was not stolen by a burglar, who, I believe, *did* effect his escape in this manner, and in justice you ought to transport the man.)

But we have not the space, nor is it needful, we think, to follow the author further in his reasoning. It may have appeared very clear to the "working classes," but it has not satisfied us that there is no alternative between "Darwinism" and "nothing."

Perhaps as we do not ask our readers to bring the "Baconian philosophy" to bear upon this inquiry, the author will allow us to draw their attention to a more modern method of treating this and all similar questions.

Induction, we have excellent authority for saying, "consists in stating the facts and the inference in such a manner that the evidence of the inference is *manifest;*" just as the logic of *deduction* "consists in stating the premisses and the conclusion in such a manner that the evidence of the conclusion is manifest." We suspect that if our authority for this definition* had read these lectures, he would have added, by "*the facts*, I mean all the known facts of importance." In the first case (the story) our author has not stated *all* the facts as they exist, but has assumed some which do not exist; in the second (his logical inquiry) he has glossed over the *importance* of the fact previously omitted, and instead of proving the case has thrown the burden of *disproof* upon his opponents.

But now we come to another inquiry. Does the author accurately state Mr. Darwin's views and inferences concerning the causes of the phenomena of organic nature, and is the author's testimony sufficiently unbiassed to warrant persons who are uninformed on scientific matters in taking him as their guide on the subject? We do not for a moment doubt that he is perfectly sincere in his enunciation of Mr. Darwin's views; but our readers shall also have an opportunity of forming an opinion on the matter, and of judging for themselves as to whether it is best to seek their information at the main stream, or to judge of its proportions from those of its tributaries.

And perhaps it will be better that we should not confine ourselves to the exposition of Mr. Darwin's views coming from a warm advocate; but that, as the opportunity presents itself, we should also lay before them those of an opponent, and they will be somewhat astonished to find how the teachings of the great naturalist have been made the key-note to any melody.

In reviewing a work of a kindred nature to the one before us,† and written by one who also wishes to be regarded as an unprejudiced witness, we deprecated *very mildly* the introduction into such inquiries as these of the *odium theologicum*, in consequence of a charge of materialism brought against Mr. Darwin by the author. He passes sentence upon that eminent naturalist by saying that his theory is "a blind chance process," resembling that of Lamarck, or the author of "The Vestiges;" indeed, he

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* Dr. Whewell.

† Page's "Past and Present Life of the Globe." Blackwood. Reviewed in "Popular Science Review," No. I.

(Mr. Darwin) merely phrases "in different terms the same materialistic hypothesis." He adduces his evidence in a foot-note, in which he says that in "the whole tenor of the 'Origin of Species' there seems to be a studied non-recognition of any higher influence than chance, external conditions, nature, law, and other kindred activities." In other words, he says that Mr. Darwin is a materialist, who ignores the existence of the Deity; and that the whole tenor of his work shows this to be the case. We will return presently to the statements of this gentleman, who is "*guided solely by a desire to arrive at Truth;*" and who wishes to "*deal charitably towards the opinions of others;*" and will pass on to those, not of an opponent, but a warm partisan—the author of the work under criticism.

Speaking of Mr. Darwin's theory:—"As I apprehend it," says our author, "for I have put it into a shape more convenient for common purposes than I could find *verbatim* in his book; as I apprehend it, I say, it is that *all the phenomena of organic nature, past and present,** result from, or are caused by, the inter-action of these properties of organic matter which we have called Atavism and Variability, with the Conditions of Existence; or, in other words, given the existence of organic matter, its tendency to transmit its properties, and its tendency occasionally to vary; and lastly, given the conditions of existence by which organic matter is surrounded; that these put together *are the causes of the present and past conditions of organic nature.*"

Judging from the remarkable similarity between these two versions of Mr. Darwin's theory, our readers might be disposed to think that both writers must be correct—the opponent, who stigmatises him as an atheist, or something akin to it; and the advocate, who appears to endorse his views. But we will now let Mr. Darwin speak for himself:—

"I *believe*† that animals have descended from at most four or five progenitors, and plants from an equal or lesser number. Analogy would lead me one step further, namely, to the belief that all animals and plants have descended from some one prototype. *But analogy may be a deceitful guide.*"‡ . . . (After showing that all living things have certain properties in common) . . . "Therefore I should infer from analogy that *probably* all the organic beings which have ever lived on this earth have descended from some one primordial form, *into which life was breathed.*"

Again:—

"Authors of the highest eminence seem to be fully satisfied with the view that each species has been independently created. *To my mind it accords better with what we know of the laws impressed on matter* BY THE CREATOR *that the production* and extinction of the past and present inhabitants of the world should have been due to secondary causes, like those determining the birth and death of the individual."‖

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* These italics are our own.
† Here also the italics are ours.
‡ Origin of Species, p. 484.
‖ Ibid. p. 488.

And thirdly:—

"There is a grandeur in this view of *life* with its several powers, *having been originally breathed into a few forms or into one;* and that whilst this planet has gone cycling on according to the fixed laws of gravity, from so simple a beginning, endless forms most beautiful and most wonderful have been and are being evolved." *

The author first referred to, who declares himself to be the seeker of "truth," and who wishes to deal "*charitably* towards the opinions of others," has in his work quoted the last extract, in which our readers will perceive that the Creator is *referred to*, but not named; but he sedulously avoids noticing the second paragraph, which he might have found (if he did not find it) on the preceding page; and although he condescendingly gives Mr. Darwin credit for *geniality*, as evinced in the paragraph last quoted, and the context; yet he condemns him for appealing to *chance* and *nature* (not to *prescience* and *Almighty Power*, mark!) for all subsequent development, "as if these blind deities† were aught without the direction of the same original life-breathing impulse!" *Ergo, Mr. Darwin is a materialist.* Now, without expressing our individual opinion (which may or may not, for causes other than those under consideration, be at variance with Mr. Darwin's), we would ask our readers to say honestly, who has formed the highest conception of the Creator, he who believes that the Deity said, "Let it be," and so it is for ever; or he who believes that the command is *of no avail* unless the Lawgiver watches for ever over the execution of His laws, lest they should vary or be broken?

As to the misrepresentation, we say nothing. Our readers well know how to value the testimony of such a witness for the future. One thing is quite certain. A proceeding of this kind is by no means calculated to enforce a recognition of the hand of the Creator in His works.

But if this writer has misconstrued Mr. Darwin, we think our readers will agree with us that Professor Huxley has been far from happy in *his* interpretation of the views of that eminent naturalist, and that neither commentator has conferred a benefit on the object of his criticisms.

Mr. Darwin does *not* say, "given the origin," or "given the existence of organic matter, its tendency to transmit its properties, &c." . . . "these are the causes of the present and past conditions of organic nature."

What he does say, we have given in his own words, and it is unnecessary to repeat them. He modestly expresses his conviction in a certain theory in regard to the production of all species, past and present, from a few forms, and draws attention to the fact that the same reasoning might lead to the belief that all are descended from one prototype. He shows that the phenomena which form the basis of his belief are due to secondary causes; but he has taken care to let his readers distinctly understand that he has never lost sight of the Great First Cause, speaking with

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* P. 490.

† There is nothing in Mr. Darwin's work to warrant this expression: "These obedient servants" would have been correct.

becoming modesty and caution of the laws which he sees operating in nature, and only approaching the Lawgiver with reverence at the conclusion of his labours to pay him his tribute of praise in what appears to him to be the most fitting manner. His interpreter, or critic, whichever our author claims to be, whilst he confounds the naturalist's inference as to what is *probable*, with his belief, founded upon actual observation, concerning secondary causes, totally ignores the author's reference to the First Cause.

Mr. Darwin addresses the world of science; and he does so, as we just observed, modestly, cautiously, and with due regard to the difficulties that militate against the acceptance of his own theory. *In fact, he is by far the fairest critic who has ever dealt with the views that he himself has propounded.*

His interpreter to the *working classes*, and to many very young students, harangues these with great ability, and with unbounded confidence in his own opinion concerning all that his author believes, and all that he supposes him to believe in regard to secondary causes; but in his address he completely ignores his reference to the Creator.

It is about seventy years since a remarkably able French naturalist, Lamarck, drew attention to what we may call the "theory of progressive development" in the animal races; but his method of explaining the visible phenomena has not been deemed satisfactory. He was unable to show "experimentally that even races could be produced" as *he* supposes species to have originated. Now another naturalist, of equal ability, has shown that, under certain conditions,* races *can* be produced artificially; but he has not been able to evolve a new species from a variety, and his theory is admitted by himself to be imperfect. On this second attempt to solve the mystery of nature, our author steps forward and says to the masses (many of whom have never before heard the name of Lamarck mentioned), "Lamarck was a speculator (not quite such an objectionable one as some one else whom he names) and his theory has pretty well dropped into oblivion, as it deserved to do. Put him on the shelf, and if persons tell you that Mr. Darwin is groping towards truth as he did, I won't instruct you what to think of their judgment, but will leave you to think what you like, and *believe in Darwin*. 'Darwinism, or nothing,' is my motto —to-day—but, mind, I don't pledge myself to him, and should anything turn up to-morrow, that appears to serve our purpose better, I shall come and tell you so." We confess we cannot hold our beliefs with such a "light hand," and "part with them as cheerfully" as does the author, "the moment they are proved contrary to fact, great or small," and we repeat, that for the present, we prefer Nothingism to "Darwinism." Thus, at least, we shall retain our judgment for any emergency that may arise hereafter.

Whilst referring to "isms," we cannot refrain from mentioning that there

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* To understand this question properly, and judge of the difference between the views of Lamarck and Darwin, the reader should carefully consider both, as there are similarities between them which do not appear on the surface.

are expressions in the work before us which are calculated to bring it into connection with an "ism" of a most unenviable kind, and the author and our readers shall judge for themselves whether or not we are right in saying that they are *ill-chosen*, in addressing the "working classes." In speaking of the limits of human inquiry,* he says, that all our knowledge and all our investigation cannot take us beyond the limits set by the finite and restricted character of our faculties (a declaration, by the way, *hardly* in accordance with what he has said of man elsewhere†), "or destroy the endless unknown which accompanies, *like its shadow*, the endless procession of phenomena."

Let it be clearly understood that we do not, even by inference, desire to bring the grave charge against our author, which is so thoughtlessly bandied about by the ignorant or bigoted, a proceeding which we have ourselves deprecated in another; but we repeat, that this and similar expressions are *ill-chosen* in an address to the working classes.

And now, turning again to facts. Mr. Darwin has very properly said that there are "many and grave objections" which may be advanced against his theory; but we must add that there are also many striking facts which point to the special formation of new species from varieties—but not under the conditions and through the agencies attributed to Nature by Mr. Darwin.

In treating of the *origin* of varieties, Professor Huxley speaks of the birth of a six-fingered human being, and also of the production of a remarkable variety of sheep. These cases the author refers to "spontaneous variation," but he is so wedded to his adopted theory, that they do not suggest to him anything beyond chance. They are "accidental variations." This may be so, or it may not; but we will grant that it is so. Is there nothing to be learned from the *first appearance* of these "monstrosities?" If "Darwinism" be unable to account for these mysterious apparitions in nature, may they not serve as a clue to something higher than "Darwinism?"

Apparently the six-fingered man is really a monstrosity—and his appearance proves nothing more than that an unprecedented and apparently inexplicable change may take place in nature, and what the author would call an abnormal feature may appear to be perpetuated.

Of the long-bodied, bow-legged sheep, it can hardly be said that it was a *monstrosity*,—if so, it was a most convenient one to its owner, for it was just as useful to him as if he had *designedly* made such a sheep! Monstrosity or not, it was a very useful variation in the breed, with which (as far as evidence shows) neither atavism, variability (strictly speaking), nor the conditions of existence, had anything to do; yet it was remarkably adapted to the requirements of its owner and to the conditions in which he found it, and he therefore proceeded at once to perpetuate its peculiarities and form a new race. If we are to reason from art to nature,

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* P. 135.

† "Natural History Review," No. I. (1861), p. 67, line 22, "The only earthly being of *practically unlimited* powers."

or, more correctly speaking, from the human to the Divine, then we have here a clue to the mode in which a new species *may* have been brought into existence when circumstances required it. The *type* is here created in complete adaptation to external circumstances, and is then, by external conditions (the hereditary transmission of peculiarities, &c.), perpetuated as a race.

We recommend to the earnest consideration of our author the question of "spontaneous variation."

Pasteur's experiments can hardly be said to have given the *coup de grace* to the theory of "*spontaneous generation*,"* for some months before the author delivered these lectures, Professor Wyman, of Boston, had published his experiments (which were a repetition of those of Pasteur), with precisely the opposite result at which the French chemist had arrived. And, moreover, if *man* succeeds in making a living protozoon or protophyte out of inorganic substances,—a possibility which, according to the author's views, may be realised before fifty years have elapsed,—this "direct method" will be the strongest evidence that the Creator still continues to supply the earth's surface with the germs of these lowly forms through the operations of nature; for where are the necessary conditions the most likely to exist?—most certainly in nature, according to the author's view of the Darwinian hypothesis.†

Speaking of Professor Wyman, we do not exactly see the applicability of the author's reference to that gentleman's anecdote of the "Paint-root" and the "black pigs," with regard to natural selection.‡

The argument is that the most minute cause will sometimes save a species from extermination, and a case of "selection of colour" is here mentioned; namely, that in a locality where a certain root grows in Florida it has killed all the *white* pigs which have fed upon it (their hoofs cracking before death), whilst to the *black* pigs it is innocuous; consequently black pigs only are to be found there. Are we to understand that the black *colour* of the pigs is the "minute circumstance" which saved their lives? We cannot read it otherwise; yet it appears to us highly probable that the colour had nothing whatever to do with the phenomenon, but that it was only an unimportant concomitant of some very important difference between the two kinds of pigs, of which the narrators (the inhabitants) were ignorant. There are certain substances which act as poisons if taken by the lower animals, but are harmless to higher forms of life. This we presume is due to some very important physiological difference between them; and is it not merely an extension of the *actual* (not the alleged) cause that saved the black pigs?

Geological and Palæontological Records.§—The author tells us that in

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* As stated at p. 82.

† It must not be understood that from this we advocate the theory of "spontaneous generation;" we are simply considering it from the author's point of view.

‡ Pages 130, 131. This is Mr. Darwin's argument.

§ Page 31, et seq.

these records there can be no cavilling, as in the histories of human origin "Nature's records," he says, "are laid clearly before us, and the facts state themselves; the question of the credibility of the natural record will require but little consideration.

We are at a loss to know why this statement was advanced by the author. It leads the reader to suppose that there can be no quibbling in regard to geological or palæontological evidence, but the sequel shows that not only is that evidence very scanty, but what there is of it is liable to extreme misinterpretation. He even goes so far as to say that if man had access "to every part of the earth (instead of only to 'about the 140,000th part of the accessible earth'), and had made sections of the whole, and put them all together, even then his record must of necessity be imperfect."

The fact is that the records of nature pretty much resemble those of man; and a comparison of the two records is calculated to impress even the most sceptical with the wonderful unity and all-pervading influence exercised by that Eternal Mind, which is gradually initiating us into the mysteries of nature, and instructing us in regard to the history of the universe.

In the world's physical history we have certain grand, well-defined eras; and so also in the history of our race. Strata, whose characters are unmistakeable stand side by side with dynasties and empires, regarding which we have an extensive fund of general knowledge. How long the strata were in arriving at their present state, or for what length of time they were uppermost, is at present very doubtful; what numbers of centuries the empires or dynasties were dominant, or the period which elapsed between their rise and fall, is in many cases equally debateable.

So, too, we have well-marked records of the animals which inhabited the globe during the depositions of the various strata; and their remains enable us to reconstruct and vivify and compare each group with its predecessors, or with those that succeeded them. The same obtains in human history, where sepulchres, mummies, hieroglyphics, arms, implements, and other antiquarian treasures are the indestructible traces which enable us once more to recall the different peoples to life, and to study their character and instincts. In both classes of facts our knowledge is daily increasing, and no one can with justice say that one record is more reliable than the other, nor predict with safety that "all human knowledge must stop somewhere."

When the author gives a "practical" definition of "species" (one, by the way, which is very convenient for his argument), and falls back completely upon structural differences; and when he states that "whether a physiological test between species exist or not, it is hardly ever applicable by the practical naturalist;"* he should remember that as his definition was derived from animals "in a state of nature," it is only right to ascertain whether or not Nature herself applies a test of species. Or, to speak more plainly, whilst he was careful not to omit the mention of any

* P. 109.

evidence which he could find in artificial breeding, or in nature, to show that animals might be and have been produced by his process of selection, which differ from another so widely in their *structure* as to constitute *apparent* species, would it not have been fair to such of his readers and hearers as are uninformed on the subject, to lay stress upon those *obstacles* presented by Nature herself to the amalgamation of *acknowledged* species? Is it not a fact that the higher animals are endowed with instincts (*functional* attributes so to speak) which act as a repelling influence between species and prevent them from breeding *at all*,* and are not the lower forms of existence (such as insects) actually furnished with appendages, *structural* peculiarities, which render a fusion of species *absolutely impossible?*

Indeed, leaving the domestic animals out of the question, and putting that stock-example the Rock pigeon aside for a moment, we would ask our author whether there is any property of "species" in nature, any one of its numerous designations so prominent and immutable as the physiological bar to cross-breeding. This may or may not affect the question at issue, but when the author dwells upon the "capricious character of sterility," and rakes up all the evidence he can find in favour of a theory which he is subjecting to a "critical examination," it appears but just to his hearers to tell them not only what is abnormal, but also what is almost the undeviating rule in nature. For after all it must be remembered that Mr. Darwin seeks to prove that new species have been found in *nature* and by *natural* selection; and even if he produces a new species by artificial breeding, "analogy may be a deceitful guide."

And now, finally, we come to the question of Man; a subject which we approach with "humility and hesitation" akin to that which the author experienced when he dealt with the "great art and mystery" of pigeon breeding, and one upon which in all earnestness "a man must not speak lightly."

The author believes that man is an improvement from some lower animal; but in this he tells us that he is expressing not Mr. Darwin's, but his own view; and he proceeds, popularly and very briefly, to communicate to the masses his well-known opinions on this subject.

Here, again, we confess ourselves greatly disappointed. There can be no doubt that the author carries with him the approval of a large number of the leading physiologists of the day in his views concerning the alleged *structural* differences between man and the ape; but from the illustration before us we should say that it is an easier task for him to pull down an edifice than it is to build it up afresh with the old materials.

Man is no longer to be judged by structural peculiarities, he tells us; and first he proceeds to drive his opponents out of the field before installing himself in their place, and introducing a new *régime*.

He has been asked, he says, how he accounts for the vast intellectual

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* We lay stress upon these words, because the author does mention that the results of an intercrossing of species produces different results (when it occurs) to that of varieties.

difference that exists between man and the ape, as compared with the almost imperceptible structural variations between them; whilst at the same time he affirms that all functions—intellectual, moral, &c.—are the *result of* structures.

Here is the reply:—

There is a great misconception as to the "real relations which exist between structure and function, between mechanism and work." Although one is related to the other, function being "the expression of molecular forces and arrangements," yet it does not follow that one must keep pace with the other; and if it could be shown "that a variation in function which follows on a variation in structure may be enormously greater than the variation in structure, then, you see, the objection falls to the ground."

But of course this is an "hypothesis," and one which, it might be thought, could easily be proved by natural phenomena in the same manner as the Darwinian hypothesis. The author, however, prefers having recourse to the mechanical world for his evidence, and proceeds to tell his hearers that he will take two watches, "made by the same maker, and as completely alike as possible, and, laying them side by side, will set them going." He then, with the aid of a pair of pliers, "just lightly crushes together the bearings of the balance-wheel" of one of them, and the watch so treated will cease to go. Thus, he says, a "slight structural alteration" leads to "an infinite difference in the performance of the functions of these two instruments."

Passing from mechanical art to the natural world, he says that it is the power of speech which makes man what he is; that a slight imperfection or derangement in his organs of speech would make man dumb; that "a race of dumb men, deprived of all communication with those who could speak, would be little indeed removed from the brutes;" and that "the moral and intellectual difference between them (such men) and ourselves would be practically infinite, whilst the naturalist would not be able to find a single shadow of even specific structural difference."

The author has expressed such contempt for "inductive and deductive philosophy" (and perhaps with justice, in speaking to the working classes), that we feel almost disposed to follow his directions and weigh his argument, as he endeavoured to test Mr. Darwin's hypothesis—namely, by analogies in every-day life. But we have no more space for long stories, so we must be excused if we in this instance revert to the old system, and thus endeavour to ascertain whether the reasoning is sound and conclusive, and whether the propositions are based upon facts.

This appears to be the author's argument:—

1st. Slight variations in structure may produce immense differences in the accompanying function, which is the expression of structure.

2nd. Of two watches made exactly alike, you may stop the function of one (which function is its rate of going) by slightly altering its mechanism. *And, again*, speech is the function which distinguishes man from the brutes, and speech is the result of a slight structural attribute, which, being deranged or rendered imperfect, induces dumbness.

3rdly. Therefore, a trifling difference in the structure of man (the im-

perceptible change which might be caused in his glottis) is followed by an infinite variation in function (speech or dumbness, as the case may be, and its results).

As in the former case, the argument may seem clear and conclusive to our author; but it is not so to our apprehension.

The first proposition, which it is unecessary to repeat, is denied by his opponents, or rather he undertakes to prove its accuracy, and that he seeks to do in his second. But his second does not appear to us to consist of facts, for in dealing with the watches he neither brings about a structural alteration, such as he requires for his argument, nor does that alteration result in a variation in functional *action* (for that is the point at issue). He simply *injures* the mechanism, and completely arrests, or destroys, its functional action. If the author had shown that by effecting some imperceptible change in the mechanism of one watch, he could make it go *immeasurably faster* than the other, then his simile would have been appropriate; but we could not have accepted it as evidence in favour of his argument. It would *then* only have been a simile; but as it now stands, it is not even a pertinent one. Had the author told us to place by the side of these watches two men made by the same Maker, and as completely alike as possible; and that if we or the Maker (the Maker in preference, as He understands His handiwork the best) were to derange some minute vital organ, he would cease to live, and that all his vital functions would be stopped, we should have said that the analogy holds good, and should have seen in it an evidence of the feeble tie that unites body and soul. But as it stands, it does not bring us a step nearer to a conclusion, being simply irrelevant, and we must pass it by; and proceeding to the natural illustration, man's speech, we take exception to it on the ground that it assumes as a fact what is not so, namely, that it is speech which "constitutes and makes man what he is," &c.

In the first place, speech is a mere instrument of the mind; and, secondly, it is not by any means so infallible an instrument as the hand (aided, of course, by the chisel, the pen, or the pencil). It is certainly not tradition which has "enabled man to record his experience," and constituted him what he is at present. And, finally, it is very doubtful whether a race of dumb men, circumstanced as the author states, would be so degraded as he seems to think. Their progress would be slow, but their human attributes would not be extinguished by the absence of this one faculty.*

Now if these exceptions which we have made to the author's propositions be well grounded, he has simply failed (as far as his examples go) to prove that a "variation in function, which follows on a variation in structure, may be enormously greater than the variation in structure;" but if he had proved this exceptional law (and we apprehend that the author does not regard it as a *general* one), still we should have protested

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* We should add that precisely the same mode of treatment has been adopted by the author in dealing with his *men*, as with his *watches*. He does not bring about an immense variation in function; but, as in the case of the watches, he completely *stops* the functions of one of them.

against its application to the nature of man, in the sense in which the author applies it; namely, that the advantage which he has over the lower animals in being able to speak, "constitutes and makes him what he is;" and we believe that in so doing we should have the approval of our readers; and perhaps, after mature consideration, that of our author.

In another place,* we thus endeavoured, in a familiar manner, to point out the characteristic which distinguishes man from the lower animals:—

"The advocates of such theories as that of Darwin, and those who refuse to acknowledge some trifling attribute of man's bodily nature as a sufficient evidence to justify his severance from the lower animals, are even in this enlightened age branded as heretics and infidels, and the more charitably disposed speak of their doctrines in a fearful whisper. But is it not far more 'orthodox' to discard such trifling considerations, and seek the true characteristics of our race in those *mental* attributes by virtue of which man towers so high above his inferior companions on earth? Is not the power to write the name of his Maker a more obvious distinction than the 'opposable thumb' with which he holds his pen to perform the act? Are not the mental qualities that enable him to appreciate the beneficence of that Maker far more important attributes of his nature than any trifling peculiarity in the temporary and perishable organ by which his mind operates?"

In the same place, too, we referred with satisfaction to the opinions of one who claims a higher title to be heard on such matters than we do; and the particular expression which seemed to call for our approval was this:—

"For whether, as some think, man is by his origin distinct from all other living beings, or whether, as others suppose, he is the result of the modification of some other mammal, his duties and his aspirations must, I apprehend, remain the same. The proof of his claim to independent parentage will not change the brutishness of man's lower nature; nor, except to those valet souls who cannot see greatness in their fellow because his father was a cobbler, will the demonstration of a pithecoid pedigree† one whit diminish man's divine right of kingship over nature, nor lower the princely dignity of perfect manhood, which is an order of nobility, not inherited, but to be won by each of us, as he consciously seeks good and avoids evil, and puts the faculties with which he is endowed to their fittest use."

In this definition of the nature of man, as compared with the lower animals, no reference is made to his organ of speech; but his characteristic attributes are found in the *mind*, and in his conscious power of discriminating between right and wrong. His prerogative is not any unimportant structural feature, nor yet his function of speech—it is his *moral nature*, and we accepted this definition from its author, Professor Huxley,‡ as an earnest of something nobler that was concealed in the background.

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* The *Times*, April 3, 1861. "Natural History," by John Hunter: a Review.

† *i.e.*, descent from the ape.

‡ "Natural History Review," No. I., 1861, p. 67.

But in the present work we seek in vain for the recognition of man's religious nature, and we are tempted to inquire whether the conviction of his "pithecoid pedigree" has, after all, entailed with it a less noble estimate of his character, in contradiction to the very principles laid down in the foregoing extract, and whether we are to understand that he is now hung up a little higher than the parrot and the jackdaw. We prefer, however, to abide by the old definition of years gone by, and to hope on for a recognition of his noblest attribute—his faith in, and reverence for, an invisible Creator.

And, finally, we must be excused if we indulge in a little personality, which is indispensable to a full statement of our reasons for having given such prominence to this little work.

Had it emanated from an ignorant fanatic, or from some unknown scribbler, who would seek through the enunciation of extreme views to obtain notoriety where fame was unattainable, we should have ignored its existence. But it is not so; and if we may judge by rumour—

"A pipe,
Blown by surmises, jealousies, conjectures,"

and not usually given to undeserved laudation, the author of this treatise is a gentleman who, through the affection which he inspires in his students (young men whose opinions will mould the fair form of Science, God's handmaid, in the future, and *to whom Mr. Darwin appeals for judgment on his labours*), through his generosity and kindness to rising men of his own profession, and through his daily increasing fame arising from his researches in the field of science, is likely to exercise a wide and permanent influence on every class of society. We should be undeserving, therefore, of the confidence to which we aspire, if we failed to direct public attention to what appears to us unsound reasoning in a work written by such a man, and directed to the particular class for whose instruction these lectures have been published.

Postscript.—Since the foregoing notice was concluded, we have received Professor Huxley's work on "Man's Place in Nature." We, of course, reserve our judgment on its merits until we have read it carefully. Meanwhile, we may mention that whilst the author employs more caution in speaking of Mr. Darwin's hypothesis in this later work, which is intended for scientific men and the general public, yet a hasty glance over its contents affords us no opportunity of recalling anything that we have said concerning the one here reviewed, which was specially addressed to the working classes.

MISCELLANEA.

SCIENCE ON THE CONTINENT.

New Methods of Engraving.—Efforts have been made in all directions to supersede the art of the engraver by mechanical and philosophical means, and many plans, more or less available, have been adopted or published from time to time; but M. Dulos, member of the Academy of Sciences, and engraver to the Imperial Board that has the charge of the roads and bridges of France, has recently made public a very ingenious system which he has practised for some considerable time. His process, to adopt his own words, is based on the following facts:—"If quicksilver be thrown upon a horizontal plate of silver or copper silvered, upon which any design has been traced with varnish, the mercury will dispose itself on the unvarnished portions of the plate and assume a convex form of a certain height. The same, as is well known, will occur when water is poured on a plate of ground glass on which a design has been traced with any fatty substance. In short, any liquid will act in the same manner, when brought into contact after the same fashion with substances for which it has different degrees of affinity."

The methods employed by M. Dulos are as follows:—For the production of an engraving to be printed by the copper-plate press, he produces the writing or design by means of lithographic ink, or chalk, or some other similar greasy composition, on a plate of silver or silvered copper; and then he deposits on the plate so prepared a thin coating of copper or iron, by the galvanic process, leaving, of course, the design uncovered. The ink or chalk is then removed by means of turpentine, and the design appears in silver, while the whites or interstices are represented by the deposited iron or copper. Mercury is then thrown on the plate and attaches itself to the silver only, and the excess being swept from the iron by means of a very soft camel-hair pencil, the design itself is represented by the convex surface of the mercury. A mould is then carefully taken in plaster or melted wax; the surface of this is metallized and casts taken from it, by means of the galvanic pile, which serve as the printing plates. For letter-press printing, the design is drawn on a copper plate, and a thin coating of silver is deposited on those parts not touched by the drawing material; the latter is then removed either by turpentine or benzine, the copper portions thus exposed are oxidized, and the operation is completed as before described. An intaglio plate may also be produced by using copper for the writing or drawing, depositing thereon a coat of iron, then removing the ink or chalk and depositing silver on the exposed copper. Another and apparently superior mode of proceeding is to make use of

fusible metal mixed with a small portion of mercury, in place of the latter only; when this mixture is melted it acts in the same manner as mercury, and when cold the copper may be deposited directly upon it, and the necessity for the wax or plaster model, and copper matrix, done away with. The methods above detailed are not however suitable for delicate work, the removal of the excess of the mercury or of the fusible amalgam endangering fine lines. For superior purposes, therefore, M. Dulos makes uses of an amalgam of copper which he lays on a silver plate, upon which the design is already drawn, by means of a silvered roller which deposits the amalgam on the exposed silver portions of the plate, but leaves the iron coating entirely free. The Academy of Sciences has appointed a commission to report on these processes, and the result is awaited with considerable interest.

HELIOCHROMY.*—A recent report, by M. Niepce de Saint-Victor, to the Academy of Sciences, contains much matter of interest, not only as regards the photography of colours, but also in connection with the great question of the spectrum analysis. It is well known that yellow is the colour which presents the greatest difficulties to the photographer, and especially in heliochromy; but M. Niepce de Saint-Victor has at length succeeded, as he informs us, in producing the yellow tints with certainty, and in connection with other colours. Previously, he says, he could obtain red, blue, and green; but whenever yellow came, it was always by accident. The means by which he at length succeeded in reproducing yellow tints, was by the substitution of a bath of hyperchloride of soda in place of potash. The recipe given for this bath is as follows:—"Take fresh-made hyperchloride of soda, marking 6° of the aëométre, mix it with an equal quantity of water, and add alcohol in proportion of one-half per cent. of the soda; raise the mixture to the temperature of 70° or 80° centigrade (say 160° to 175° Fahrenheit), pour it into a flat dish, then plunge the silver plate into the bath for a few seconds, agitating the solution at the same time, until the plate assumes an almost black tint; then rinse it in plenty of water, dry it over a spirit-lamp, and warm the plate as much as necessary. A bath containing six or seven ounces of the solution is sufficient for the preparation of five or six quarter-sized plates. With plates thus prepared the colours are produced very brilliantly, especially by direct contact, and the blacks are often given in all their intensity. For the camera, M. Niepce de Saint-Victor recommends that the plates should not have too thick a coat of chlorate of silver, and that they should be of a fine cherry-coloured tint after being heated; he also says, that the plate should be covered with a varnish with chlorate of lead for its basis. As regards the fixing of the colours, M. Niepce de Saint-Victor announces, that he has succeeded in getting them to last a much longer time than he was formerly able to do, (but not yet in making them permanent), and the best means he has yet discovered for this purpose, is the tincture of benjamin of Siam, applied to the plate when the latter is warm.

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* The process of photography in which pictures are obtained in their natural colours.

After it is dry, the plate should be warmed again, in order to drive off a little of the benzoic acid. By these means, he says that he has been able to preserve the colours for three or four days, in an apartment fully exposed to a July sun.

That part of the memoir which relates to the different effects of the so-called primitive and binary colours is highly important. It declares all secondary colours to be decomposed in the process of Heliochromy; and in order to show the effect of light on a mixed colour, he selects green as affording the most remarkable instance. If, he says, the green be natural, such as that of the emerald, of arsenite of copper, of oxide of chromium, of sulphate of nickel, of green carbonate of copper, it will be reproduced on the heliochromic plate; but if it be a mixed green, formed, for instance, of chrome yellow and Prussian blue, that of a fabric dyed with a similarly mixed colour, or of glass coloured by means of yellow and blue pigments mixed, then the product by the heliochromic process is invariably blue, whether produced by direct action or in the camera. Again, a light blue-coloured and a light yellow glass placed together produce a fine transparent green; but whatever be the period of exposure, and however the glasses are placed, whether the blue be above or below, or even if it be imprisoned between two yellow glasses, the result is invariably not green, but blue.

In like manner, a red and yellow glass placed together, produce an orange colour when held up to the light; but they uniformly give red only to the heliochromic plate: a red and blue glass in combination produce at first a violet colour on the plate, which is of itself red, but it soon changes to blue. Paper coloured green by means of the leaves of trees, or by the *vert de vessie*, French "Chinese green" (extracted from the buckthorn), acts very slowly upon the plate, but eventually produces a greyish-blue tint, and the same occurs on attempting to reproduce natural foliage of a grass-green colour by means of the camera. But if the leaves are of a bluish-green tint, such, for example, as those of the dahlia, the blue produced on the plate is more decided; whereas, dead leaves, of a yellow or red colour, produce on the plate yellow or red, more or less pure, according to the absence of the blue matter which has been shown to give the green colour to foliage. The eye in the feather of the peacock's tail is well reproduced on the plate in the camera, the colour varying between blue and green, according to the angle of incidence at which the light is allowed to fall on the plate. This report seems to hold forth a fair promise, that should Heliochromy fail in its direct intention, it may afford valuable aid in the important inquiry into the composition of the solar spectrum, and in the evolution of a true theory of colours.

Bonelli's Printing Telegraph.—A governmental inquiry is now being made into this invention, which is in operation in England, and is said to be capable of printing 500 despatches of twenty-five words each per hour, an achievement which, it is admitted, would require, under the system in use here, twenty wires and fifty clerks; if the trials give a satisfactory result, it is said that M. Bonelli's arrangement will be at once adopted on the Paris, Lyons, and Marseilles line of railway.

Non-Arsenical Green Pigment.—The *Chemisch-technische Mittheilungen* contains an account of a new green colour. Dr. Elsner having

had occasion to test a powder called *green cinnabar*, found that it was composed of prussian blue and chrome yellow, and reports that, although from the nature of the prussian blue it is not applicable for the painting of walls containing lime, or fit for colouring sweetmeats and other edible compounds, it is well adapted to supply the place of the dangerous arsenical green pigments used in paper staining, and may be produced in every shade, from the lightest to the darkest. The following is the method given for producing the pigment:—Mix together, in the first place, solutions of yellow chromate and yellow prussiate of potash; next take solutions of the acetate of lead and iron; mix these also together and then with the former compound, and a green precipitate will be produced, the tint of which will depend on the proportions of the various ingredients; the greater the quantity of the prussiate of potash and acetate of lead employed, the lighter, of course, will be the colour. The precipitate must be carefully washed and dried with a gentle heat. Dr. Elsner recommends the production of the acetate of iron by the precipitation of a solution of acetate of lead by means of sulphate of iron, and the filtering the residuary liquor.

The Effect of Syrups on Linen.—A French chemist has made some interesting experiments on the effect of syrup on textile fabrics. A piece of cambric was brought to him which seemed to have been burned by an acid, but which in fact had only had some drops of syrup of tolu dropped upon it. The chemist, M. P. Doré, tested the remainder of the liquid, and found it perfectly pure, consisting only of balsam of tolu, sugar, and water. He then dropped some of the same syrup on a piece of linen and dried it, and found to his surprise that it had rendered the fabric perfectly rotten. He sought for the cause of this apparent phenomenon, and came to the conclusion that it resulted simply from the rigidity given to the fibres by the absorption of the sugar. It is well known that frozen linen, or that which has been much starched, is brittle from a like cause. M. Doré says, that certain French weavers strengthen the threads of their warps by means of paste, but that as the effect would be lost by dryness, the unfortunate men are compelled to work in damp rooms and even in cellars.

Mechanical Perforation of Rocks.—A young engineer named Leschot, has invented a curious method of piercing rocks for mining purposes. Many attempts have been made in this direction, but with little success, and M. Leschot has hit upon the happy expedient of cutting out a solid cylindrical piece, instead of making his machine act upon the whole surface of the matter to be removed, thereby avoiding an immense amount of labour, and saving a vast deal of time. The new cutter is tubular, and its effect is to isolate a small column of the material, which can easily be removed by the action of a wedge. It consists of an iron tube whose outer diameter is equal to that of the required hole, and furnished with a steel ring carrying what may be called a crown of diamonds. The tubular piercer is made to revolve by machinery, and is at the same time pressed forward, making a circular incision in the rock, and the dust is prevented from accumulating by a current of water which is forced down the tube, and which at the same time prevents the heating of

the cutter. That such a tool will make its way into a rock is evident; the question is at what rate and at what cost. The following are the particulars furnished on that head:—The power of one man, aided by a winch and gearing, is declared to be sufficient to cause the tool to enter hard granite, at the rate of about half an inch a minute; and one quarter of a horse steam power will, it is said, produce nearly double that amount of work. A cylindrical piece of granite, more than 10 inches long, and 1¼ in diameter, is said to have been removed in 13½ minutes, leaving, with the portion cut away by the tool, a hole of nearly 2 inches diameter. As regards expense, it is stated that a tool will cut many yards of the hardest jasper or granite, without any apparent injury to the diamonds, which are of course of the commonest kind; the cost of the steel ring with the stones being originally little more than five pounds, while the value of the remains of the diamonds when worn down to the steel setting is given at about four-fifths of the original cost. The new drilling tool is now being put to a practical test in the mines of Saint-Chamond.

New Life-buoy.—This simple but ingenious arrangement for saving life and valuable property is the invention of M. Fonteneau, and has been reported upon most favourably both in England and France. It consists of a strong cask, having on one side a large trap, or door, made of bronze, and shutting down airtight by means of a screw, and on the opposite side a heavy piece of metal, to serve as ballast and keep the door always upwards. At each end of the cask are fixed strong iron handles or rails. In case of shipwreck, several of these life-buoys may be placed in the boats, or towed alongside, or used for the construction of a raft, papers and other valuables and provisions being placed inside. In the worst case, the bars at the end enable persons in the water to support themselves till help arrives. One recommendation of the new life-buoy is, that they cause no inconvenience on board ship, as they may be used as ordinary water-casks.

Soldering of full Water-Pipes.—The following ingenious contrivance is worth recording. A leaden water-pipe was broken by accident, and it was difficult to shut off the water; the plumber plugged the two ends, and then, having surrounded each with a quantity of ice and sea-salt, the water within the pipe was frozen solid in five minutes. The plugs were then withdrawn, the joint made, and in five minutes more the ice within was melted and the pipe in perfect condition.

Transplanting of Large Trees.—Sir Joseph Paxton and other English horticulturists were, we believe, the first who attempted, or at any rate perfected, the system of removing large trees from one place to another; but during the last few years it has been practised in Paris to an extent unknown elsewhere. At spring and fall the transplanting-trucks, or wheeled frames, are to be seen in all directions, and the Champs Elyseés, the Boulevards, and the various squares recently laid out in many parts of the town, have been adorned with thousands of noble trees by these means. A report was made on the subject the other day to the Central Society of Horticulture, by which we are told, that horse-chestnuts more than 39 inches in diameter, and a catalpa-tree 150 years old and 23 inches in diameter, have been transplanted with success. Another and very remarkable case is mentioned, namely, that of three good-sized trees,

growing in such a manner that they could not be separated, having been removed together from a private garden about to be destroyed, the mass of roots and earth measuring 5 mètres, or about 16 feet English in length.

It has been discovered, that the bleeding of trees and the attacks of insects, after the cutting off of branches, may be effectually stopped by the very simple method of well brushing the part exposed with a paste made of wood-ashes and water; the ash enters between the fibres of the wood and prevents exudation, while the alkaline property of the mixture keeps off the insects.

PRIZES OF THE FRENCH ACADEMY OF SCIENCES.—This branch of the Institute has recently announced its list of prizes granted in 1862, and offered for competition in the present and succeeding years. Amongst the former is Lalande's Astronomical Prize, given to Mr. Clark for the construction of an achromatic lens 18½ inches in diameter, and the discovery by its means of a small star in the neighbourhood of Sirius. The proposed prizes include some of great importance. An extraordinary prize of 6,000 francs is offered in connection with the application of steam to naval purposes; a grand prize of 20,000 francs is to be given, in 1866, for the best method of preserving limbs by the conservation of the periosteum. "It has been proved by numerous physiological facts," says the report, "that the periosteum has the faculty of producing bone, and remarkable instances have been exhibited of very large portions of bone being replaced in the human body by means of the preservation of the periosteum. The time is therefore arrived to call the attention of surgeons to a new and most important study, which is equally interesting to science and important to humanity." The Bordin Prize of 3,000 francs is offered, this year, for a "history, anatomical and physical, of coral and other zoophytes of the same family," especial attention being drawn to the natural riches and commercial importance of Algeria in respect to these products. According to the report, the coral-fishery is carried on actively only in the French portion of the Mediterranean, which may be true; but certainly it is hardly correct to say, as the same document does, that "the production of coral is limited to this sea." The grand Bréant Prize of 100,000 francs is offered, this year, for the cure of Asiatic cholera; the successful candidate must produce a medicine which will cure the disease in the great majority of cases; he must indicate in an unquestionable manner the causes of this so-called epidemic with a view to their removal; and, lastly, he must discover a preventive as decided as is vaccination against the small-pox. Failing this, 4,000 francs will be given to the discoverer of the actual existence in the atmosphere of matters which act a part in the production or propagation of epidemic diseases; or, for a radical cure for cutaneous eruptions, and an exposition of the causes which give rise to them. The Barbier Prize of 2,000 francs is offered, this year, for the best work on chemistry or medical botany. Several, if not all, of the above rewards are open to general competition, and the exact conditions in each instance may be obtained by application to the secretary of the Academy.

PARIS, *March*, 1863. Y.

SCIENCE SCHOOLS AND CLASSES.

ON SCIENCE SCHOOLS: THEIR FORMATION AND WORKING.

BY H. P. MEADEN, F.C.S., SCIENCE TEACHER.

SINCE the issue by the Department of Science and Art of the Minute, 2nd July, 1859, by which aid is afforded to the industrial classes in procuring instruction in science, the number of certificated teachers of science, of their schools, and of their pupils has very largely increased.

After the examination, November, 1859, the number of *certificated teachers* was 59; after that, in 1861, it was 158; and at the present time the number will exceed 200. Of *science schools* there were 4 in 1859; 9 in 1860; about 38 in 1861; while the number at present is more than 80. Of *pupils* there were 438 under instruction in 1859; 500 in 1860; 1,130 in 1861, and nearly 2,000 in 1862.

At the annual examinations there were 600 pupils "passed" in May, 1861, and about 1,350 in 1862. These numbers represent about three-fourths of the competing candidates. Much of the success attending the development of the scheme is doubtless owing to the following liberal arrangements:—(*a*), that the office of science teacher is open to all successful aspirants; (*b*), that the classes are under *local* management, and with little interference as respects details from the central authority; and (*c*), that payments are made to teachers on *results*.

Science Teachers.—Many teachers, certificated in science, are employed in National and other day schools, under the Education Department. Those with pupil teachers under them are precluded from taking advantage of the Science Minute, and have, therefore, done little in actual *science teaching*. The classes which have been established are mainly taught by persons entirely or partially engaged in instruction in mechanics' institutions, trade schools, navigation and mining schools, &c., or by such persons as analytical chemists and draughtsmen. They are thus suitable for the office, being "apt to teach," but not dependent on science only for their livelihood, and a fair share of success has been achieved by them. In reference to the abilities of those seeking the office of science teacher, it may be noted that the number who failed to gain certificates in 1860 formed but one-fourth of the competitors; in 1861 only one-eighth; and last year (1862) the proportion was again about one-fourth. Most of the teachers hold certificates in several subjects, and in many cases they have undergone a subsequent examination, in order to improve the *grade* of their certificates; thus "showing," as Captain Donnelly, the Science Inspector, says in his Report for 1861, "the great advantage of having the system of payments in aid, though dependent on results, so adjusted as to allow the personal qualification of the teacher to count for something, thereby encouraging him to go on improving himself." This remark will probably not apply quite so strongly under the Revised Science Code as

heretofore. As might be expected, there is great disparity in the number of teachers in the different subjects. About three-fourths are certificated in chemistry; one-third in experimental physics; while in drawing, geology, &c., and the branches of natural history, the proportion is much smaller. Many of the masters, however, conduct classes in more than one subject.

Pupils in Science Classes.—Although the Science Examinations and Queen's Prizes are open to middle-class candidates under certain conditions, as well as to the industrial orders, the latter greatly predominate in number from the nature of the scheme—state payments being made to teachers for the instruction of *artizans only*. In course of time, middle-class schools will no doubt provide for scientific education to a greater extent than exists at present.

Guided by the returns of the last May examination, the following table shows approximately the social standing and relative number per cent. of the "passed" students, numbering about 1,330:—

	Themselves.	Their Children.	Total.
Proportion of schoolmasters and other teachers	8·27	0·75	9·02
„ „ Pupil teachers	3·46	—	3·46
„ „ Clerks, of various grades, bookkeepers, &c....	17·21	6·60	23·81
„ „ Chemists, druggists, and apprentices	5·79	0·67	6·46
„ „ Handicraftsmen	14·36	9·32	23·68
„ „ Mill-hands, as weavers, &c.	3·30	0·90	4·20
„ „ Shop-keepers	2·33	6·31	8·64
„ „ Mine-agents, miners ...	0·90	0·37	1·27
„ „ Superior workmen, foremen, &c.	9·55	7·36	16·91
„ „ Middle-class persons... ...	0·45	2·10	2·55
	65·62	34·38	100·00

The most striking features in this table are, that the proportion of teachers is larger than might have been expected; as in most examinations, clerks figure most numerously—the highest, in fact—though they are nearly equalled by the handicraftsmen. The higher class of workmen and superintendents of works are well represented, while the number of persons connected with mining is very small compared with the number examined in geology, mineralogy, and mining. The workers in mills are almost confined to Lancashire and Yorkshire. Middle-class pupils form but one-fortieth of the whole.

It appears that 66 per cent., or nearly two-thirds of the whole, are earning their own living, the remainder being at school or at home. The average age of the pupils is about twenty-one; in some subjects the range is higher, and in others lower. The greatest number of juveniles is found in the chemistry and animal physiology classes; these subjects being taught in some day-schools, where there are large classes, and chemistry being the most popular subject with boys.

The fair sex appeared to have entered into all the subjects (except drawing and physics), but more especially those of animal physiology, geology, and mineralogy. In the latter subjects, indeed, they decidedly take the lead, and occupy a fair place at all times. They seem to be almost confined to the classes in Ireland, Liverpool, and Stroud. Now that several ladies have taken science certificates, and others will probably follow, we may expect to hear of classes for females only, being established. The beneficial influence which such teaching may exert, even upon future generations, is inestimable.

The Science Classes are, in the majority of cases, held in public institutions and schools which possess the advantage of being central and well-known resorts. A responsible committee already exists in them, suitable rooms can be obtained, the work of science teaching can be at once commenced; the class being formed and recruited from the members of the institution or school, and thus becomes a part of the educational machinery of the place. The charges made for instruction vary in different places, according to circumstances, usually ranging from two to ten shillings per annum; and it is questionable whether more would be paid at present by the working classes, except in special cases. The time per week devoted to one subject seldom exceeds one and a half or two hours. The subjects which appear to be most studied by those requiring a knowledge of them in their daily employment, are, Drawing, Chemistry, and Mechanical Physics: the remaining subjects (with the exception of Mining) being more suitable to all classes of persons.

As in most new undertakings, considerable obstacles and disappointments are experienced in conducting science schools with satisfaction. The necessity and advantage of obtaining science instruction have still to be made evident to many masters and workmen; so that the demand is not yet great, and in this respect we are behind some of our neighbours on the continent.

At the opening of a Science Class a fair number of students generally enrol themselves, and promise to do well. But some have miscalculated their taste and perseverance; others are irregular in their attendance, and thus lose the connective parts of the subject; the time or the place is not suitable to others, *and it is only the real hard working students who persevere regularly and steadily through the entire year's course of lectures, and attend the Government examinations.*

These remarks will not, however, apply with equal force to *Day Schools* where science is taught. A considerable drawback to success in these classes, especially when tested by paper examinations only, is the defective English education of some of the most promising students, and hence much of the teacher's labour is very inadequately represented in the results of the May examinations.

Many of the above difficulties may, however, be overcome by judicious management, and the assistance of those who should encourage efforts for the promotion of science instruction. Masters, in large works connected with the mechanical and chemical arts especially, might lend their countenance and aid in forming classes for their workmen. Farmers in agricultural districts would not find their crops worse or less abundant by

obtaining for their sons a knowledge of the principles of agricultural chemistry, or of natural history. Many of the large public and private schools are very tardy in introducing science to their "list of subjects taught."

Much depends also on the teachers. It is for them, by their clear instructions and good illustrations and experiments, to draw out the thinking powers of the students, and enlist their sympathy in the subject. It cannot be expected that all will be equally interested; but the dormant powers may often be thus roused to active inquiry and keen observation. As much as possible the pupils should engage in *practical* work. The conjunctive action of the hands and head often generates an interest not otherwise attainable; and workers are fond of using their hands. They should be encouraged to experiment at home; to collect and arrange specimens, as in the formation of a local museum. Much interest is excited when the pupils will associate out of class hours for mutual help; in the discussion of points in their studies; for excursions in search of natural history and geological specimens; and for visits to museums and other places of interest. They would thus be preparing themselves to become useful members of any scientific society in the locality; friendships would be cemented; their subjects would grow upon them, and become a part of their existence, and a source of never-failing gratification. The perusal of scientific magazines by the advanced students will put them in communion with the superior labourers in the same field with themselves, and lead some, at least, to assist in unfolding the "unknown" in nature.*

As an encouragement to deserving pupils, where the classes are large, one or two of the most promising students might be selected to act as *science pupil teachers* upon a plan similar to those in art and elementary schools. Their duties should be to *repeat* the lesson to young and backward students, or those joining the class at other times than the commencement of the course. If recognized by the Department of Science and Art, a gratuity or other inducement might be afforded to such pupil teachers. In preparing for the yearly examinations, and, indeed, at all times, it is well to accustom pupils to commit their knowledge to paper; and great pains will be required on the part of the teacher in guiding them to state what they know in a short, clear, and full manner, with due attention to the correct use of scientific language. In the May examinations, the examiners have, so far, very wisely, required sound teaching in the first principles of their subjects: this course should be strictly persevered in, if a good superstructure is to be raised; while questions of

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* The students of the Liverpool School of Science have established a "Students' Association," of which the objects are, to circulate scientific books and periodicals, and at suitable seasons to organize excursions with the teachers. About forty students joined the Association at its commencement, and paid an annual subscription of 2*s.* 6*d.* each, to which several added a donation. We understand that it is working well, and that the best scientific works are circulated amongst the members. It is under the management of a committee of students elected by the members. Perhaps this example may be deemed worthy of imitation elsewhere. *Ed.*

greater difficulty may, very properly, be set for the more advanced pupils. Success in these examinations will encourage the students to persevere in their studies; and it is not too much to expect that some of those who are fortunate enough to secure the Scholarships and Free Admissions to the Government School of Mines, after steadily persevering in the curriculum of studies at that institution, may become useful labourers in the cause of science, and, it may be, celebrated for their high attainments and untiring zeal in promoting by their labours the comfort and happiness of their fellow-men.

THE GLASGOW SCIENCE CLASSES.

In our last number we had the pleasure to record the successes and honours of many enterprising and diligent *students* obtained at the annual examinations of the Science and Art Department; and now it affords us gratification to enumerate some cases in which *teachers* were enabled to earn honours and secure certificates of competency. One instance is peculiarly gratifying, and deserves especial notice. It appears that, notwithstanding the great obstacles which militate against the attendance of young ladies at the South Kensington Teachers' Examination—difficulties to which we have frequently referred in these pages, and which we think could be easily obviated by a little judicious management—a young lady in Glasgow (Miss Macomish), lately a student in the Free Normal Training College, and at Mr. Mayer's Science Classes, had the courage to go up to London (for the first time), without any companion to protect her, and there attended the Teachers' Examination last November. She obtained a first-class certificate in Animal Physiology, and will no doubt establish a class for ladies in that subject.

We cannot speak too highly of this young lady's spirit, nor too warmly recommend her example to others of her sex; and we once more direct the attention of those who desire to see this movement prosper to the removal of the difficulties which now deter female teachers from visiting London for the purpose of taking out their certificates on science.* From the same city (Glasgow) two gentlemen attended the examination—Mr. John Robertson, who took out certificates in Physics and Inorganic Chemistry; and Mr. Mayer, the teacher (and we believe founder) of the Science Classes, who obtained a certificate of high rank in Metallurgy and one in Systematic Botany.

BELFAST SCIENCE CLASS.

No doubt our readers who are interested in the subject will remember how highly we praised Mr. Ralph Tate, in our number of last October, drawing attention to the fact that he passed 82 students in one branch of science only; of whom 37 carried off prizes of various grades.

We are glad to find that in his case the proverb does not hold good, that

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* See p. 417.

"a man is never a prophet in his own country," for on the 28th of October, at the distribution of prizes, he and his students reaped their several rewards; and we feel sure that the reception he met with from his townsmen will induce Mr. Tate to renew his efforts in the excellent cause in which he is embarked. "There was a large and fashionable attendance on the occasion," and all that art and nature could effect in the way of decoration was done to render the meeting attractive.

The leading people of Belfast attended; and we are very glad to see amongst those who were present the name of Wyville Thomson, Esq., a Professor of Queen's College, Belfast, and one of the editors of the *Natural History Review*. We select the name of this gentleman, who is personally unknown to us, because we think that much of the success of the movement depends upon the countenance and encouragement which it receives from men who hold his position in the scientific world, and who support the movement for its own sake, and for the promulgation of scientific knowledge. Professor Thomson is one of the committee of the Belfast classes.

At the prize distribution Mr. Herdman, the secretary, stated that Mr. Tate has "certificates in six out of seven subjects, in which the Department grants them," and that "the Department considered him the best teacher they have."

Perhaps the most interesting portion of the ceremony was, however, the distribution of prizes; for we believe we never read so large an amount of good common sense compressed into a small space, as that uttered by Mr. R. Davidson, the prize distributor. Without pretending to possess scientific attainments himself, this gentleman, who appears to be advanced in years, and to have learnt to appreciate the value of science, expressed fully the views of the laity concerning the rational pursuit of this branch of knowledge; and the "puerile objections" raised by "weak and narrow minds" to its prosecution on theological grounds.

We really believe that this crusade against the enemies of science (which is becoming so general that we can hardly take up a report of any scientific meeting without finding in it the onslaught of some belted knight) will soon become *fashionable*, and we may hope that then many hearts will be turned, and science schools will be in great request, and become "paying concerns." What a prospect for science teachers! We trust they will keep an eye upon all individual changes of sentiment in this respect and *charge accordingly*.

Mr. Davidson mentioned that eight young ladies have received rewards for merit, and we believe they belonged chiefly to the middle classes. We shall be glad to record the names and achievements of those who take out teachers' certificates, and establish "Science Classes for *Female* Students."

POSTSCRIPT.—On page 81 ("Popular Science Review" No. 5) we omitted to mention amongst the "most successful schools and classes," those at Glasgow, Salford, and Haslingden. We hope the conductors of these classes will pardon the inadvertent omissions, and as we have already stated, we shall be very glad to give publicity to any communications which are likely to benefit classes about to be, or already established.

FURTHER CHANGES IN THE SCIENCE CODE.

Since the preceding article went to press, the following changes have been made in the Science code.

1. In addition to the teachers' examinations, held annually at South Kensington, London, there will be a simultaneous one in Edinburgh and Dublin, "if five candidates register themselves in Ireland or Scotland."

We have great pleasure in publishing this alteration in the code, as being an important step towards facilitating the admission of ladies amongst science teachers.)

2. In 1864, books will no longer be given to second and third class prizemen, but "cards of merit, recording the result of the examination," will be substituted.
3. Only one (instead of two) silver medals, and two (instead of three) bronze medals, will be granted to successful students in each subject.

(*This change will inflict serious injury upon the whole movement, the books being one of the chief inducements to young persons to become students: and the chance of gaining a medal is already sufficiently small in subjects in which there are many competitors.*)

4. The travelling expenses of candidates for teachers' certificates will in future only be paid to those who are *bonâ fide* engaged in tuition or preparing for it.

GEOMETRY AND CRYSTALLOGRAPHY.

On the Divisions of the Cube, by Mr. Charles M. Willich.—Mr. Charles M. Willich, Secretary to the University Life Assurance Society, has, for a considerable period, been engaged in researches in pure and applied geometry, on the divisions of the cube, and the solids which result from these subdivisions. As early as October, 1860, he had brought before the notice of the French Academy of Science a memoir in which he had arrived at extremely curious results, which we propose to recapitulate.

The solid triedral angle of the cell of the bee is formed of three plane angles, having each an angle of 109° 28′ 16″. The ordinary dodecahedron with rhombic faces may be deduced from the cube in many different ways. If, from the centre of a cube, planes of divisions be made passing through the edges of the six squares which form its surface, there will result six pyramids with square bases. If these six pyramids have their square bases placed on the six faces of another cube of similar dimensions, the ordinary rhombic dodecahedron is formed, which has, consequently, the volume of two cubes. Two of the pyramids derived from the cube being joined base to base, form an octahedron, the volume of which is one-third of that of the cube, and, consequently, one-sixth of the volume of the above described dodecahedron. If one of these pyramids be cut into two equal parts, and the two halves be brought together by turning them

over, a solid is formed, three of which form a rhombohedron. Four such rhombohedrons form the dodecahedron with rhombic faces, and seven of these rhombohedrons afford a prolonged dodecahedron, which is that of the cell of the bee.

Mr. Willich has subsequently discovered some new subdivisions of the cube, one of which is especially interesting. It is produced by carrying through the alternate solid angles of the cube six planes meeting at its centre; these planes divide the cube into four equal and similar parts. The solids thus produced have precisely the same solid angle as that of the roof of the bee's cell. Consequently if these solids be grouped back to back, one-half of a rhomboidal dodecahedron is produced. Each of these solids, equal to a fourth part of the cube, is formed of two triedral pyramids united together; the angle of one is 109° 28′ 16″, that of the other 90°. If each of these four double pyramids be divided into two other triangular pyramids, it will be found that the four pyramids having an angle of 109° 28′ 16″, form the regular tetrahedron, the solid content of which is, consequently, one-third that of the cube from which it is derived; that the four other pyramids, the angle of which is 90°, turned over and placed back to back, constitute a pyramid with four equilateral faces, equal to half the regular octahedron, and equal in consequence to two-thirds of the primary cube. Thus, the same analogy will be found to subsist between these three bodies as there is between the cylinder, the sphere, and the cone; in the sense that the cube, the quadrangular pyramid derived from it, and the regular tetrahedron, are precisely in the ratio of the three numbers 3, 2, 1.

By another kind of section which consists in carrying the intersecting planes through the diagonals of the six faces of the cube, four solids are cut off, leaving in the centre a regular tetrahedron. These four solids are similar to four of the solids previously obtained, and form similarly a quadrangular pyramid which is half a regular octahedron.

The solids resulting from the section of the cube have yielded to Mr. Willich, amongst many others, two polyhedrons very deserving of attention—one, with eight summits, results from the reunion of two tetrahedrons, and its volume compared with that of the cube from which it is derived is $2\frac{2}{3}$. The second has twelve summits, and its volume is four cubes. The former polyhedron with eight summits is reduced by the simple removal of its summits to the regular octahedron having equilateral triangles for the faces of the octahedron, the volume of which is one and a third times the volume of the cube; it is thus the volume of the whole of the eight tetrahedrons which have been removed.

The second polyhedron is formed, as already stated, of four cubes, and is reduced to the rhomboidal dodecahedron by the removal of its summits. These twelve summits removed, have the volume of two cubes, as has likewise the remaining dodecahedron. The sum of Mr. Willich's researches renders the conclusion highly probable that the symmetrical polyhedrons which result from the union of the sections of the cube, or of the elementary solids of which it is composed, comprehend not only all the polyhedrons of geometry, but nearly all regular crystals. (*Les Mondes*, No. 4, pp. 55-57.) H. W. B.

SCIENTIFIC SUMMARY.

QUARTERLY RETROSPECT.

ASTRONOMY.

Difference of Longitude between Greenwich and Valentia.—The Astronomer Royal, under whose superintendence this inquiry was determined in 1845, by the transmission of chronometers, has recently verified it by signalling with the electric telegraph, when almost exactly the same result was arrived at. It is strange that there should have been so great a difference in the result found by these two processes in the case of Cambridge and Greenwich (a comparatively short distance), namely, by chronometers in 1828 and by telegraph in 1853; but probably greater precautions had been taken in the carriage of the chronometers in the Valentia expedition. It is stated that the current took one-tenth of a second to traverse the 800 miles of wire.

This is, however, only a preparatory step, before endeavouring to determine the length of the arc between the most western point of Europe (Valentia, in Ireland), and the town of Orsk, in the east of Russia. By combining the numerous old and some new triangulations, which it will be necessary to take, it is intended to measure this in *yards*. The distance between the two stations is *seventy degrees*, so it may be imagined how many units of that popular cloth-measure shall be swallowed by this mensuration. The differences of time at the east and west points will be obtained, when available, by the telegraph.

The Elchies Refractor.—In our last summary we gave Professor Smyth's experiences with this instrument (11-inch aperture), showing the existence of many small stars whose places had not been previously recorded. Mr. Dawes has, however, been able to detect many, if not all, of those with a telescope of 8¼ inches aperture. He points out that "the most valuable property in a telescope is undoubtedly a fine sharp definition;" and concludes that an object-glass of 11 inches will show a star whose magnitude is about 12¼ of Struve's scale, or 18½ of Sir J. Herschell's. Mr. Knott has also been able to detect all the stars of 222 Piazzi I., the star B., missed by Professor Smyth, being readily seen.

Variable Stars.—A proposal has been made for establishing an association for the systematic observation of variable stars. A similar association was formed some sixty years since for the detection of the smaller

planets, each observer taking a particular district of the ecliptic, and some good results followed the attempt. These were, however, surpassed by the individual exertions of later years—each planet-seeker working promiscuously. Now, however, that the list has attained such dimensions, the question of variable stars is a favourable field for division of labour.

Mr. Knott finds that the variable star R. Vulpeculæ may reasonably be classed under the head of regular variables, although he at first suspected some irregularities in its change of brightness. He observed it at its brightest point, 1861, Dec. 30, and 1862, Oct. 4, being only $3\frac{1}{2}$ and 4 days later than the times predicted by Dr. Winnecke, and giving a period of $138\frac{3}{4}$ days.

The variable star U. Geminorum, which Mr. Pogson describes to be subject to such remarkable changes, *viz.*, from the 9th to the 13th May, in intervals from nine to fifteen seconds, still continues its eccentric course. Mr. Baxendell observed it on Dec. 26, 1862, of the $10\frac{1}{2}$ mag., when it should have been below the 14th; on the 29th and 30th it was invisible. Mr. Knott assumes it from observation to have been invisible, or below $12\frac{1}{2}$ mag., on Dec. 20.

Stellar Spectra.— This subject appears to be in rather a confused state at present, for Professor Donati finds different lines from Frauenhofer in nearly all the stars; and a careful American experimentalist again differs from Donati. The latter astronomer, however, made use of the micrometer in determining their places, and he thinks that if only eye-measures are employed one may be easily deceived, owing to the extreme faintness of the colour, in which the reddish tinge is the only one visible. Frauenhofer finds a fine line in the green, Donati in the blue. The former finds, between the yellow and red, a line in Pollux, Capella, Alpha (Orionis), and Procyon, which the latter has never seen. Frauenhofer found Procyon very difficult, whilst Donati found it easy. As the Astronomer Royal has instituted a series of experiments we may expect these points to be speedily determined.

Photographs of the Moon.—Mr. De la Rue has succeeded in obtaining an enlarged picture of the moon, equal in size to the great map of Beer and Maedler, *viz.*, 38 inches in diameter; the original negative being only one inch in diameter. There must be a combination of very favourable circumstances in order to obtain a good picture—"atmosphere, collodion, instrument, driving clock, all must be perfect." Mr. De la Rue has taken four hundred negatives during the last five years, yet of those only about twenty are capable of producing a perfectly sharp photographic record. The beautiful specimens which we have seen at the Exhibition prove that this vast amount of labour has been well rewarded.

The fine specimens of lunar photography, accompanying Dr. Vengeur d'Orsan's book on the moon, were much admired when they first came out; but circumstances have since occurred which have in a great degree disturbed and affected this opinion of their merits, and doubts are expressed, not as to their accuracy, but as to their originality. If they be original, it will of course be a simple matter to produce others not bearing such a resemblance to those of Mr. De La Rue, which are known to be *bonâ fide* pictures.

Spots on the Sun.—During the past quarter the sun has been very rich in spots, and many groups along the equator were seen at the beginning of March. A spot, seen on March 1, to the western side of the sun, appeared of a spiral form; but two days later it did not seem to have shifted its direction, although it was considerably broken up and a quantity of luminous matter was mixed up with the penumbra and nucleus. Mr. Howlett questions the existence of the notch on the sun, photographed by Mr. Titterton (of Ely) on the morning of August 4, which was doubtless seen by many at the Exhibition. He observed the sun three times on that occasion, and could still distinctly see its margin. It would appear that the eye on such occasions is more sensible than the collodion, Mr. Howlett being able throughout the day to perceive a brilliant streak of photosphere between the spot and sun's limb, whilst the photograph makes the spot and sky run together, thus producing the notch. A similar occurrence took place on October 1, the photograph showing a notch, and the telescope none.

At the December meeting of the Astronomical Society, the Astronomer Royal exhibited a picture of the fringes of light seen on a wall before the disappearance of the sun in the total eclipse of 1861, December 31, taken by Captain Poulain at Goree. The wall was white, and five bands were observed, each four inches broad, three white and two dusky dark. The length of the fringes was in the same plane as the tangent to the discs of the sun and moon at the place of its last disappearance. These flitting shadows have been noticed previously, but the explanation is still obscure. They were particularly seen in the eclipses of 1842.

Saturn.—From observations of Saturn made about the time of the disappearance of the ring in May last, M. Struve thinks that there are certain luminous appendages which are not the same as the ansæ of the ring. They extended to a distance equal to one-half or one-third the diameter of the ring, differing much from the ordinary colour of the ring, being of a livid colour, brown and blue; their size increasing at the margins of the planet, giving them the form of sharp wedges. From a communication made to the Astronomical Society in December, these curious appendages were likewise observed by Mr. Wray at the disappearance of the ring in 1861, December 26, and 1862, January 5. It gave him the impression that it was the dusky ring, very much thicker than the bright rings, and seen edgewise, projected on the sky.

Mars.—Mr. Joynson, of Liverpool, submitted a series of thirty-six drawings of Mars to the Astronomical Society, made between September 25, and November 10, 1862. He concludes from these that the band is continuous around the planet, except where a pale yellow stripe crossed it; that the snow at the south pole was not exactly at the axis of rotation and that the time of rotation was 24h. 37m. 49s. Mr. Grove thinks that changes take place in the distribution of the lights and shadows of Mars by clouds condensed over large aqueous districts.

Halley's Comet.—M. Angstrom, by comparing all the known appear-

ances of Halley's comet, has proved the existence of two new periodic inequalities in the time of its revolution, by the combined action of which the time of the appearance of the comet may be accelerated or retarded from one revolution to another by about a year and a half.

Occultations and Eclipses at Sea.—Mr. David Smith denies the impracticability of observing such phenomena at sea, and proves it by his own example, he having taken such observations with a common ship's glass. He states that unless the ship is very uneasy, stars up to the 3rd magnitude are easily observed.

Parallax of Stars.—The parallax of 61 Cygni, found by Bessel to be 0″.366, was afterwards found by Struve to be 0″.51. M. Auwers brings it nearer still, making it 0″.57.

Planets and Comets.—The bright comet of August and September, 1862, is found to have an elliptical orbit with a period of 142 years. The first of the two comets detected by M. Bruhns on November 28, was discovered three days earlier by Professor Respighi at Bologna. No new planets have been discovered since the Danish Goddess Freia, detected at Copenhagen, November 14, 1862, by D'Arrest. Some fine spots are now visible on Jupiter.

BOTANY.

Cinchona Trees.—The Indian Government has been forming plantations of cinchona trees on a large scale on the Neilgherry Hills. The total number of plants at present is 72,568; of these, 13,700 are placed permanently out of doors, 18,076 are in the plantation nurseries, and the remainder are small, and kept under glass. Extensive clearings, amounting to 700 acres, are being made for further planting of this valuable tree.

Substitutes for Cinchona.—MM. Joret and Homolle have presented to the Society of Pharmacy at Paris, a new product obtained from common parsley seeds (*Apium graveolens*), to which they have given the name of Apiol, and for which they claim the medicinal properties of Peruvian bark. Another plant, much used in India for the same purposes as cinchona, has been lately introduced into France by the Société d'Acclimatization, *viz.*, the seeds of Cæsalpinia Bonducella, or the Natha plant, which, according to Mr. Hayes, their correspondent, is a small creeper, producing a nut, the kernel of which is extremely bitter, and possesses, in an eminent degree, the qualities of Peruvian bark. It is proposed to cultivate the plant in Algeria and the south of France.

Sun spurge (*Euphorbia helioscopia*).—The "Annales d'Hygiène Publique" states that the goats of the island of Malta, after feeding upon this plant, called by the inhabitants Tenhuta, have produced noxious milk, which caused symptoms of poisoning in the case of several officers of English vessels in the harbour.

The Blue-gum tree (*Eucalyptus globulus*).—This magnificent tree, a native of Australia, is now in course of cultivation at Algiers, and in the

Jardin des Plantes, at Paris, where a few good subjects are now being reared. This tree only bears blossoms at the very top, so that to get at its flowers, its discoverer, M. Labillardière (in 1792), was obliged to have one cut down. The circumference of the base was about 90 feet, and 65 feet at the height of five feet from the ground; its total altitude was 300 feet, and the section presented upwards of 800 concentric rings. The wood is extremely hard, and used as timber for ship-building purposes, dykes and piers at Hobart Town, and the leaves emit a delightful perfume. In 1860, Dr. Müller sent over some seeds of this tree to the French Minister of Marine, who immediately dispatched them to M. Hardy, the director of the nursery at Algiers; and there is every reason to believe that this remarkable and beautiful tree will be acclimatized in France, or, at least, in Algeria.

The Mistletoe.—A correspondent, Mr. Birschel, of Liverpool, referring to the paper on this subject by Mrs. Lankester, in the last number of the "Popular Science Review," states that having been brought up in a country abounding in forests of black fir and pine (the Vosges mountains), he thinks the statement that the "instances of the mistletoe attacking the coniferæ are very rare" should be modified. The parasite abounds in these forests, and people make a livelihood by gathering it at certain seasons, as food for cattle; but while it is to be frequently found on the black fir, he states that he has never seen it upon the pine. It is more common upon old and stately trees than upon young or dwarfish individuals.

Raphides in British Plants.—Mr. Gulliver, F.R.S., after an examination of many hundred British Phanerogamic plants, found raphides in the following, while in a much larger number of others they were not detected. In many other orders not here noticed they were looked for, but not found. *Caryophyllaceæ;* in *Silene armeria. Onagraceæ;* raphides are characteristic of this order, and serve to distinguish it from the allied orders, Lythraceæ and Halorageæ. *Rubiaceæ;* common in the genera Sherardia, Asperula, and Galium. *Compositæ;* raphides less common here than other forms of crystals but they are found in the subdivisions, Corymbiferæ, Cynarocephalæ, and Cichoraceæ. *Dioscoreaceæ;* found in black bryony (*Tamus*). *Orchidaceæ;* abundant in all the plants examined. *Iridaceæ;* in *Iris pseudacorus. Liliaceæ; Endymion nutans*, abundant in all parts of the plant, but not found in, bear garlick (*Allium ursinum*). *Typhaceæ;* in sparganium, but not in Typha. *Araceæ;* abundant in *Arum maculatum. Lemnaceæ;* abundant in *Lemna trisulca;* scanty in *Lemna polyrhiza* and *L. gibba.* In conclusion, Mr. Gulliver remarks that the abundance of raphides of phosphate of lime in *Lemna minor* (or common duck-weed), associated with quantities of starch granules, point out that despised and abject weed as a most valuable one to be used as a highly fertilizing manure.

Fruiting of the Oak.—M. Alphonse de Candolle calls attention to a new character in the oak; viz., that certain oaks ripen their fruit at the end of the first year, while others do so in the course of the following year. For half a century this character has been neglected; and it has just been found that under the name of *Quercus suber* (cork oak) two species have been confounded,—one with annual, and the other with biennial fruit. Although,

however, this character, when once determined, is perfectly fixed to each species, it is not linked with any other, and consequently two species very analogous may present fruits, in the one, annual, and in the other, biennial.

Colouring Matter of Flowers.—"The Natural History Review" gives the observations of M. Hildebrand upon this subject, the conclusions of which are, that the colours of flowers are in constant connection with the contents of the cells, and never with the cell-wall. Blue, violet, or rose-colour, and (if there be no yellow) deep red, are due to a cell-fluid of corresponding colour; while yellow, orange, and green, are usually associated with solid granular or vesicular substances in the cells. Brown or grey, and, in many cases, bright red and orange, apparently uniform to the naked eye, are found to be compounded of other colours; as yellow, green, or orange, with violet or green and red; bright red and orange in like manner of blue-red with yellow or orange. Black, except in the bean, is due to a very deeply coloured cell-fluid. All the cells of an organ are very rarely uniformly coloured, and the colour usually resides in one or in a few of the outer layers of cells, while the coloured cells are but exceptionally covered by a layer of uncoloured ones. Combinations of colour are occasioned by diversely coloured matters in the same or in adjacent cells.

New Botanical Journal.—In order to fill up an acknowledged want, a scientific Botanical Magazine has just been issued by Mr. Hardwicke. It is called the "Journal of Botany, British and Foreign," and is under the able editorship of Dr. Seeman. The second number is published.

CHEMISTRY.

DR. LETHEBY'S annual report on the sanitary condition of the City of London was issued a short time ago, from which it appears that although during rainy weather there is no upward flow of sea water, in the summer time a great quantity finds its way up the river, and necessarily it will bring with it the sewage which the Board of Works have been taking so much trouble to remove out of harm's way. It will probably be brought back beyond the Houses of Parliament, and will be all the more unpleasant for being mixed with sea water; to add to the difficulty, there has not as yet been proposed any satisfactory remedy for the evil, and in fact the question what to do with the sewage is in very much the same state as when it was first brought before the attention of the public; everyone agreeing that something must be done to remedy the evil, but no one being able to satisfactorily answer the question—what is to be done? The Chinese manage these matters much better than we do in England, and instead of throwing that which is in reality an immense fortune into the sea, carefully preserve it. The Chinese greengrocer every morning when he leaves the vegetables carries away with him this objectionable matter, which is then applied to the fertilization of the soil; this no doubt accounts for its fruitfulness in that country. Of course the difficulties of employing a process of this nature in a town like London

are not to be disputed, but the real question is,—will it pay to overcome them? And this question may possibly before long be answered in the affirmative.

Dr. F. Crace Calvert has been making some experiments on the action of sulphuric acid on lead, from which it appears that pure lead is much more rapidly attacked by the acid than that containing small quantities of other metals, and in fact so small a quantity as 0·4 per cent. of tin contained in lead diminishes the action of the acid about one-third; a point of some importance to sulphuric acid manufacturers.

Drs. Lawes and Gilbert have for upwards of twenty years been making experiments on the assimilation of nitrogen by plants; their last results have reference to the question whether plants possess the power of assimilating free nitrogen. The method of procedure was to enclose the plant in a glass vessel and to supply it with a current of air which had been washed with sulphuric acid and with carbonate of soda; the soil employed had been previously ignited and allowed to cool over sulphuric acid; carbonic acid was occasionally supplied with the air that passed through the apparatus. The seeds that were allowed to germinate under these circumstances showed a singular power of prolonging their vitality; one part feeding on the nitrogenous matter set free by the decay of another part, but in no instance was there found to be an increase in the amount of combined nitrogen beyond that originally contained in the seed.

Two deaths have lately occurred from the inhalation of the vapour of nitric acid. A bottle containing the acid having been broken and the contents spilt on the floor, the fumes acted on the lungs of the two persons present to such an extent that, although they felt no immediate ill effects, they both died, one within about ten hours and the other within two days after the occurrence. This serious accident should serve as a caution to chemists, and others who are liable to be exposed to acid fumes.

M. Crova has succeeded in producing artificially the compound of acetylene and copper, which is found in the interior of copper tubes which have been employed for the conveyance of coal gas, and which possesses the property of detonating by a blow, or by a slight elevation of temperature. The mode of proceeding was to expose finely divided copper to the action of a mixture of equal volumes of air and acetylene; the absorption of gas appears to be greater if a little ammonia were present.

The very rare metal rubidium has been found to exist in a situation where few would perhaps anticipate its presence, namely, in ordinary beetroot; the raw beetroot salt has been found to contain from 0·13 to 0·21 per cent. of chloride of rubidium.

The equivalents of the two metals nickel and cobalt have lately been determined with great accuracy by Dr. W. J. Russel. He adopted the precaution of igniting the oxide of cobalt, employed for the determination of the equivalent, in a blowpipe flame, and of cooling it out of contact with the air, by which a definite protoxide was obtained; the oxide was then reduced by hydrogen. The equivalent of cobalt determined in this manner proved to be 29·37, and that of nickel, determined by a perfectly similar process, was found to be 29·369; the coincidence between the two equivalents being very striking.

M. Dietzenbacher has lately discovered some singular properties of sulphur. He found that when acted upon by small quantities of iodine, bromine, or chlorine, it became soft and malleable at the ordinary temperature, and retained this property for some time. This modification of sulphur, which was originally discovered by M. St. Clair-Deville, is insoluble in bisulphide of carbon. It is considered that this transformation may throw some light on the details of the manufacture of india-rubber vulcanized by sulphur and chloride of sulphur.

M. Ern. Guinet has been investigating the phenomena of transport through porous bodies, and has found that Mr. Graham's dialyser could be replaced by a porous vessel of pipeclay, similar to those employed for batteries. With such vessels he states that he has repeated many of Mr. Graham's experiments, and has been able to perform others which appeared impossible, with vegetable parchment. He found, for instance, that a mixture of solutions of sugar and gum were easily separated by this means, the sugar passing through the porous clay and the gum being retained. With the same apparatus he succeeded in separating caramel from bichromate of potash; and he has an experiment still going forward on an ammoniacal solution of oxide of copper. This solution could not have been submitted to dialysis with vegetable parchment on account of its action on that material.

The diffusibility of solutions of solids in other liquids was also tried, as, for instance, solutions of iodine, sulphur, and naphthaline in bisulphide of carbon; if a solution of these three substances is submitted to dialysis, the sulphur and naphthaline pass through the dialyser much sooner than the iodine, from which he infers that the smaller the molecules of which a substance is composed, the more readily do they pass through the porous diaphragm, which may be viewed as a kind of sieve. The molecules of colloids may be supposed to be made up of larger groups of atoms than those of crystalloids, and hence would be more easily retained by the diaphragm.

GEOLOGY AND PALÆONTOLOGY.

LONG before the ages of Boulder-clay, and Drift, when the climate of England was much as it is now, and about the time when the Newer Crag was deposited, the Norfolk shores were skirted with dense forests. From Happisburg to Cromer, and much farther, they are to be seen along the level of a deposit, marked by fossil shells, which indicate the sediment of old contemporary lakes and rivers, of which there is now not a trace. After a series of changes, the Drift period supervened, the forests were thrown down, and a dark brown clay, with boulders as big as cottages, was piled sixty feet high, over lake and forest, as the country sank under the sea. And now, after innumerable ages, this same sea has again eaten away part of its last-formed stratum, till the brown clay stands as a bold cliff, and exposes at its base the old land on which the forest grew. Searching among the old tree stumps we may find acorns and beech-nuts, and here, and by dredging on an extension of the bed out to sea, are gathered

large bones, commonly black, and often pyriteous. These are the remains of large mammals, which lived on the old land. There is the hippopotamus buried in the mud of the river in which he swam; the elephant among the trees which were his food; and the rhinoceros, and many others, are there too. Such is the Norfolk Forest bed, specially interesting as the earliest deposit known to contain the Mammoth.

This species, the *Elephas primigenius*, is the most abundant of the English fossil elephants: it has, too, the widest range in space, and the longest duration in time. Authentic specimens are found throughout England, France, Germany, and Italy, as far south as Rome. Thence it ranges across the steppes of Russia, through Siberia to Arctic America, and east and south to Texas. With a distribution so wide, believed to be the result of slow migration, it would be natural to expect a long-continued existence in time.

Its teeth are met with in Central Italy, in a volcanic gravel believed to be nearly, if not quite, as old as the Forest bed. The matrix abounds in crystals of *Leucite* and other minerals; so that the species certainly inhabited that district when the extinct Latian volcanoes were active.

Although it is certain that as the Glacial period advanced a few ice-clad hills were all that remained above the sea of England, so that its mammals must have died off and migrated; yet no sooner was the country dry land again, with wood, and river, and lake, than the species became as abundant as ever. In the gravels which were then forming, its remains are plentifully preserved, and it not unfrequently occurs in caves. There is here no variation in its character; nor do any of the specimens found in this, or more recent accumulations, indicate those changes which intervening space and time are generally found to have effected. Immutable he lives on, giving no indication of whence he came. The existing elephant of India is the known form most nearly resembling it, but there is nothing to suggest that he went thither, nor is there any evidence to support the supposition that a species which endured endless migrations, and changes of food and climate, for so long a period, was at last so rapidly metamorphosed into the Indian animal that no trace of the process can be found.

When the species occurs in the gravel, the *Rhinoceros etruscus*, and many of its companions in the old Forest age, have disappeared, and are replaced by *Rhinoceros tichorhinus*, and many new forms. This rhinoceros in its turn dies out, and yet the mammoth shows no signs of being on the wane.

The next most recent beds in which it is met with are the frozen Siberian gravels, whence traders in fossil ivory have collected its tusks for ages. A skeleton, with much of the skin on the head, is preserved at St. Petersburg, and, according to Von Middendorf, many entire carcases have since been discovered.

Then comes a turbary deposit in the Apennine valley of the Chiana, in Tuscany, where most of its old associates are absent, and it is now accompanied by the more modern animals, *Cervus Megaceros*, *Bison priscus*, and *Bos primigenius*, species characterizing bogs and latest accumulations, and which were probably exterminated by man,—the *Bos primigenius* being certainly slain with stone celts by early Britons.

And finally, Sir C. Lyell, long ago, described a locality in Tennessee, where the Mammoth was discovered, together with *Mastodon ohioticus*, and existing shells, in a swamp formed in a cavity of the boulder formation.

These are a few facts in the life-history of this animal. Surviving through two distinct periods, Geoffrey St. Hilaire suggested for it the name of *Dicyclotherium*. Much information on this and other topics has lately been given by Dr. Falconer, in a discursive paper on an American fossil elephant.

Mr. Salter has described many new *Phyllopod crustacea* from the palæozoic rocks; and with a view to show what bearing these have on the doctrine of transmutation of forms, has given a diagram exhibiting side by side the several genera found in palæozoic strata. Earliest in time comes the *Hymenocaris*, found in Lingula flags. This genus is characterized by a carapace in one piece, bent over the body. In the superimposed Cambro-Silurian, the order is represented by *Peltocaris*, a form with the circular shield or carapace in three pieces—that is, two equal valves, with a semicircular piece inserted between them covering the head. Between this and the previous form there is no relationship whatever. Peltocaris is succeeded in the Upper Silurians by *Ceratiocaris*, which is also in three pieces, but the valves differ much in shape, and the relation of the wedge-like rostral piece is different. However, there is that close affinity that would induce a comparative anatomist to predict the discovery of intermediate genera when the rocks shall be better explored. In the Devonian strata the genus is *Dictyocaris*, a form quite unlike the preceding, with a carapace in one piece, and bent, which seems very nearly to reproduce Hymenocaris of the old Cambrian rocks.

In the Lower Carboniferous, occur *Dithyocaris*, and the nearly allied genus *Argas*. Argas is a form very like Ceratiocaris, with the valves separate, but it appears to want the rostrum; Dithyocaris appears to have had a rostrum, but in it the valves were soldered together.

Then in the Trias we find the recent genus Apus, which resembles Dictyocaris, but not very closely. So there are, on the one hand, Hymenocaris, Dictyocaris, and Apus, forming a sort of natural succession, on which Mr. Salter remarks that, "Apus is unquestionably the most highly developed; and it is the latest." And on the other hand, Peltocaris, Ceratiocaris, Argas, and Dithyocaris, forming a sort of harmonic progression, in which the rostrum gets gradually less important, and the carapace more concentrated. We should consequently regard Dithyocaris as probably the most highly organized of this group. And it is worthy of remark that that genus is more nearly related to Apus than is Peltocaris.

The facts are few, but they appear to indicate a method or plan in the succession of life on the earth.

Geology has lately lost in Mr. Lucas Barrett one of its most accomplished students. From his earliest years there had been a great fondness for natural history specimens, and even at an early age a faculty for original observation was active, for at school he discovered a layer in the chalk rich in univalve shells, and the specimens there gathered served as a nucleus for a monograph of chalk gasteropods, long afterwards commenced for the

Palæontographical Society. In 1853 he went to Ebersdorf, where he was chiefly occupied with chemistry and botany; and made collections of minerals and plants from the Hartz.

Returning to England after a year, natural history became his sole study; and shortly afterwards an engagement was obtained in that department of the British Museum. Here he worked chiefly at the Crustacea, arranging the Cirrhipedes. When but eighteen he visited Cambridge, and Professor Sedgwick at once secured his services in classifying the fossils of the Woodwardian Museum. It was at this time he went with Mr. M'Andrew through the Northern seas to North Cape, dredging; and some idea of his knowledge and skill may be formed from the dredging papers printed in "Woodward's Mollusca," and from a communication to the "Annals of Natural History," which was translated into the principal European scientific journals. One important object of this voyage was to discover the effect of the Gulf Stream on Northern forms of life, and the result is admirably given in the dredging papers mentioned. He now became F.G.S.; and next year, 1856, still busy with the Northern problem, went alone to Baffin's Bay and West Greenland to discover an Arctic fauna *unaffected* by the Gulf Stream.

Providentially delayed at Copenhagen, he missed the first trader, which foundered at sea. It was the seal-hunting season when he arrived, and no one, native or European, could be induced to assist him, till the temptation of sugar and coffee procured the help of eight strong Esquimaux women, who, with great courage and skill, rowed him about for two months among the floating ice, in an open boat. During all this time dredging was carried on actively; and not only did he effect his purpose, and discover that lines of distribution of life drawn through the sea would, like the isothermal lines, have to bulge up and be carried far to the north on the European side; but, with a view to determining what relation in that region the life in the sea would bear to that preserved in the deposit it was helping to form, he dredged up the sea bottom. Sketches and observations, too, were made among the Greenland glaciers, and on one of these occasions he nearly lost his life. Returning to Cambridge, the treasures gathered were stored in the Woodwardian Museum, of which he may be said to have almost created and named the natural history portion.

His attention was now given almost exclusively to comparative anatomy and the study of fossil bones. But next year, in 1857, he again accompanies Mr. M'Andrew in a voyage to Vigo Bay. Here he made an extensive collection of Echinoderms, and the Northern forms of mollusca, which, though surrounded by Southern forms, here maintain themselves as an evidence of that general migration southwards of Arctic life which occurred during the glacial ages. And in conjunction with Mr. Woodward a communication was made to the Zoological Society on some *Synapta* and *Cheirodota*.

Back to his duties at Cambridge, he removed thither and arranged a large local collection of chalk fossils, purchased at the death of the Rev. T. Image, and the beautiful lias saurians presented by Mr. T. Hawkins. At the meeting of the British Association in 1858 he read an important paper, connected with the controversy between Professors Owen and

Huxley, on the nature of the atlas and axis in Plesiosaurus; and early in the same year he himself discovered the remarkable condition of the atlas and axis of Pterodactyle; and a little later detected, in the Upper Greensand, the remains of small birds, on which a communication was made to the Cambridge Philosophical Society. About this time he occasionally lectured for the Woodwardian Professor; and the wants of the class turned his attention to field-surveying, which in 1859 bore fruit in the excellent geological map of the Cambridge district.

In the previous October he became an undergraduate of Trinity College, but kept only one term; for in March, when but twenty-two, he was appointed by Sir H. Bulwer to the important office of Director of the Geological Survey of the West Indies. He now married, and within a month left England for Jamaica. Here was a field of usefulness every way worthy of his genius, and right heartily did he set about his new duties.

As was to be expected, the survey progressed rapidly, and he speedily communicated to the Geological Society a paper on some important features in the geology of the island. His duties carried him into wild unvisited parts of the country, and those who have listened to the marvellous story of his adventures in the land of the Maroon ghosts will regret that he wanted the literary faculty (or inclination) to have given us, as he might have done, as remarkable a book of travels as any of modern times.

Among his discoveries was a singular new fossil, named after him, by Mr. Woodward, *Barrettia*, but much against his wish. Dredging again was carried on actively, and among the more important results was the discovery of an Arctic fauna in the deep cold waters of the Mexican Gulf.

In the spring of last year he returned to England, bringing the result of nearly three years' work in geological maps, and a large series of West Indian produce for the Great Exhibition. He remained till October, working incessantly; now at astronomy, now analyzing West Indian minerals, now preparing his first volume on Jamaican geology, and, after attending the British Association, and taking an active part in the meeting, returned to Jamaica full of hope.

Feeling of what little value much of our knowledge is from so little being known of the ways of life of animals on the sea-bottom, he took out with him a diving apparatus in which to watch their habits, and especially to examine the coral-reefs. On the 17th of December, four descents were made in shallow water in Kingston harbour; and the following day he expressed to friends in the House of Assembly, where he was giving evidence before a Committee, the greatest delight at what he had seen. On the 19th, against all advice it is said, he determined to go down in deep water; and, as no white man was there to accompany him, pulled off with six negroes; and, having arranged everything himself, descended outside the Caps, near Port Royal, taking the signal line in his hand. For twenty minutes he gave no signals, and it was then found he had parted from the line. Unable to regain it from some cause, probably the effect of pressure of the water consequent on a rapid descent, he appears, as a desperate expedient, to have closed the escape valve of the air tube, and shortly after-

wards his lifeless body rose to the surface. On the following day he was buried in Half-tree Churchyard, Kingston. Thus sadly, at the age of twenty-five, ended as brave a life and as noble a spirit as science has ever fostered.

In a letter to the writer, Professor Sedgwick speaks of having felt for him "sentiments almost of paternal love;" and goes on to say, "Natural science has been deprived of the services of one whose genius, and zeal, and intrepidity gave a promise of a glorious harvest of honour to himself, and, I might say, to his country."

MECHANICAL SCIENCE.

The Repair of the Great Eastern.—It will be remembered that this vessel struck on a sunken rock at the entrance to Long Island Sound in August last, ripping open the outer skin of iron plate for a distance of 85 feet, the fracture measuring in width as much as 4 feet at parts. Owing to her peculiar construction with a double sheathing, the interval between the skins being divided into cells, she was enabled, notwithstanding the accident, to proceed on her voyage and land her passengers and cargo in safety. It is even thought that she might have returned to England without danger. The agents of the Company in New York, however, determined on her repair before risking another voyage, and there being no dock of sufficient size, a novel and ingenious plan was resorted to, for gaining free access to the damaged part. A timber caisson, coffer, or "scow," was constructed, 104 ft. long, 15 ft. wide, and 8 ft. high, of great strength, and fitting, as closely as might be, to the curved side of the vessel. This was sunk over the fracture, and sustained in its place by chains passed round the hull. A water-tight joint between the "scow" and the side of the vessel was constructed by means of an india-rubber hose-pipe, placed in a shallow groove round the edge of the "scow," and when the latter had been firmly fixed in its place, filled with water under pressure by a force-pump. The "scow" was then pumped dry and formed a long water-tight chamber on the outside of the vessel, to which access was gained both for men and materials by two trunks, each 6 feet square, curving upwards along the side of the vessel to a point above the water level. A patch from 4 to 6 feet wide, and 93 feet long, was then riveted over the fracture, and the vessel rendered as strong and seaworthy as before the accident. The vessel is now undergoing repair on the shores at Rock Ferry, near Liverpool; and was for several days high and dry on the beach, so that spectators could walk round and examine every part of the hull.

The Metropolitan Railway.—The opening of this subterranean line marks a successful step towards the relief of the overcrowding of metropolitan thoroughfares. The depth from the surface to the level of the rails varies from 26 to 54 feet at different parts. The tunnel is elliptical, 17 feet high and 28½ feet span, except in the deeper portions, where the height of the tunnel is increased. The gradients do not exceed 1 in

100, the curves are not less than 200 yards radius, and extreme care has been taken in the arrangement of the signals to prevent accidents. Trains are to be run at five-minute intervals, and the resources of the line have already been taxed to the utmost to convey the passengers over the short distance of 3¾ miles at present open. The locomotives are peculiar in having a condenser, and means of preventing the escape of the products of combustion whilst within the tunnels.

Pneumatic Despatch Company.—A short length of tube has been laid by this company, and is in successful operation. It is a revival, on an unobjectionable plan, of the atmospheric system of traction tried in this country and Ireland and ultimately abandoned. Formerly, as the train on the outside of the tube was actuated by a piston within it, a joint running the whole length of the tube was necessary, and the leakage from the latter was the most serious defect of the system. In the new plan the train is within the tube, itself forming the piston against which the pneumatic pressure acts. Thus the joint is dispensed with, and the area subject to pressure being much greater in proportion to the weight of the train, a less pressure suffices, and the loss from other sources of leakage is correspondingly reduced. The compression or exhaustion of the air, as the case may be, is produced by a large centrifugal fan, which, if constructed on correct principles, will be more effective and less costly than the old plan of blowing-cylinders. Some passengers have been sent through the small tube already laid down, and there is no reason why another, say 9 or 10 feet in diameter, should not be employed expressly for passenger traffic. Indeed, the impossibility of collision or explosion, and the absence of smoke and steam, would seem to point to this as a safer, healthier, and more economical system for the underground railways of London than that adopted by the Metropolitan Company.

Armour Plates and Iron-clad Vessels.—Renewed trial has been made at Portsmouth of the laminated system of armour-plating, one modification of which is in so much favour in America. In this experiment, planks of iron 2½ inches thick were attached in two layers, crossed at right angles, so as to be equivalent in weight to 5 inches of solid plate. As in all previous experiments in this country, they proved inferior in resistance to solid armour-plate. Two bent plates were tested, with a view to ascertain the relative advantages of the hot and cold bending processes, and the extent to which they each injured the material. Both plates broke up in a most extraordinary manner, and led to serious doubts of the invulnerability of the curved portions of our iron-clads. A subsequent experiment, however, exhibited a different result, and further investigation is necessary. Steel plates have again proved failures under trial. In France, armour-plates have been pierced by flat-fronted shells, as had been accomplished previously in this country; the weight of the shells 100 lb., charge 28 lb. to 33 lb., gun of the kind known in this country as the "Blakeley."

Tubular iron tripod masts, and iron chain and wire rope, are likely to supplant timber and hemp in mail-clad vessels. They are less subject to damage from shot, less obstructive to the training of the guns, and less likely to foul the screw if shot away.

Superheated Steam.—The researches of Dr. Fairbairn and Mr. Tate on

the law of expansion of superheated steam have been published, and confirm the surmise stated in a previous paper, that at temperatures considerably above the point of saturation, or at which steam is of the density which it would assume in contact with water, the law of expansion is identical with that of air and other permanent gases. Near the saturation point, the rate of expansion is much higher, and it diminishes rapidly as the temperature increases till the mean value of the constant E in the common formula becomes 458·74, that for air deduced from the experiments of Regnault being 459, and that assumed for a perfect gas by Rankine being 461·2.

Steam Sledge.—M. Routzen has matured a system of steam transit for the snow-covered roads of Northern Russia during the winter months. He employs a train of sledges, one of which carries a high-pressure engine, boiler, and windlass. The train is hauled forwards by cables attached to fixed anchorages, and the rate of progress does not exceed a mile an hour.

Aluminium Bronze, to which we have already referred, has been selected by Lieutenant-Colonel Strange as the material for the construction of the great Theodolite for the approaching trigonometrical survey of India, on account of its high tenacity (45 tons per square inch, twice that of ordinary bronze, and equal to that of steel), its great rigidity or resistance to flexure, and its unoxidability. Sterro-metal, the new alloy employed in Austria for guns, and containing $1\frac{3}{4}$ per cent. of iron, has nearly equal advantages.*

MICROSCOPY.

The Colouring Matter of the Red Sea.—Mr. H. J. Carter, of Bombay, who returned to England last June, after spending many months on the coast of Arabia, had an opportunity of seeing the colour of the Red Sea which is produced by *Trichodesmium Ehrenbergii*, an oscillatorian vegetable organism, first described by Ehrenberg in 1826. Mr. Carter describes it as a yellowish-brown oily-looking scum on the surface of the sea in large areas of many miles in extent; and once he saw a portion of brilliant red and one of intense green together in the midst of the yellow. The odour was like that of putrid chlorophyll, well known to those who have much to do with filamentous algæ. Having collected some of this scum in a bottle, by the aid of a lens he found it to consist of little short-cut bundles of filaments, like Oscillatoria. Under the microscope, specimens preserved in alcohol—the bundles in which were about $\frac{1}{50}$ in. long by $\frac{1}{1000}$ in. broad—were found to contain about 25 to 60 filaments, each about $\frac{1}{50}$ in. long and $\frac{1}{2400}$ in. broad. The bundles bore no evidence of an investing sheath, but of the filaments being held together by mucus secreted from them generally. The yellow colour is most prevalent, the red next, and the green least of all. The red colour, like the green, appears to herald the

* See also Summary of Metallurgy.

termination of some period of the existence of the species, and the intense green colour he conjectures to be indicative of sporidification.

Application of Magenta Dye to Microscopical Investigations.—At a recent meeting of the microscopical section of the Literary and Philosophical Society of Manchester, Mr. Roberts called attention to the aid that might be received in the examination of the structure of animal and vegetable tissues by the use of colouring materials. Magenta is peculiarly adapted for this purpose, in consequence of its solubility in simple water, and its inert chemical character. The nuclear structures of animal cells are deeply tinted by magenta, and by its use the nuclei of the pale blood corpuscles, of pus globules, of the renal and hepatic cells, and of all epithelial structures are brought out in great beauty, tinted of a bright carbuncle red. The *red* blood discs are tinted of a faint rose colour, and a darker red speck, not hitherto noticed, is to be observed on the periphery of the corpuscle; it undergoes some changes when treated with tannin, and subsequently with caustic potash; but this point is still under investigation.

Cleaning Diatoms.—Mr. J. A. Tulk recommends the light detachment of the diatomaceous stratum on the surface of the moist or immersed mud by the aid of a small, old salt-spoon, by which means it is taken nearly free from siliceous particles. The bottle should contain a little water. If the mud be dryer, a camel's-hair pencil is useful. They should then be strained through a piece of thin silk gauze, and placed in a saucer with an eighth of an inch of water above the stratum, and exposed for a few hours to sunlight, which in many instances causes the diatoms to ascend above the impurities, where they may be known by their brown colour, and may be separated by a camel's-hair brush. In many cases boiling in nitric acid, and washing in clean water, is all that is required. If not, successive washings in a wide-mouthed bottle gets rid of a great deal of minute matter, and further boiling in sulphuric acid and chlorate of potash, and subsequent violent shaking in clean water, gets rid of flocculent siliceous matter or mucus. When the microscope shows the supernatant fluid to be clear of siliceous particles, a whirling motion given to the diatoms in a flat-bottomed saucer, half-full of clean water, brings the frustules to the surface, whence they may be removed by the capillary dipping tube.

The supposed Microscopic Jaw.—Mr. G. Busk, F.R.S., in the *Microscopical Journal*, shows reason to believe that Mr. Spence Bate's conjecture as to the crustacean origin of this pseudo-morph is not the true explanation, and gives figures of pedicellaria-valves of species of echinus, in juxtaposition with the *jaw* itself. These pedicellariæ consist of three valves, articulated in a complex manner to each other. Each valve possesses a serrated margin, large denticles on the anterior ridge, a large denticle in front of the median ridge, and lateral condyles—all of which well agree with the appearances presented by the object in question. Mr. Busk remarks that a full account and accurate figures of the varieties which exist in the pedicellariæ of various echinidæ and asteridæ, would afford a subject for a very useful and interesting paper, and might assist, perhaps, very considerably, in the discrimination of species or genera of

those families. We may add that no one is so well qualified as Mr. Busk for such a task.

Thread Cells in Mollusca.—Dr. Strethill Wright shows that he had anticipated this discovery in a paper read before the Royal Physical Society of Edinburgh. Such cells were formerly supposed to be only found in the hydroid and helianthoid Polyps and the Medusæ. Professor Allman afterwards discovered them in a species of *Loxodes*, a protozoan animalcule. Dr. Wright found them in an Annelid *Spio Seticornis*, and in the tentacles of Cydippe, one of the *Ctenophora*. Since then he has observed them on the very minute tentacles of Alcinoë, another of the *Ctenophora*. In all these classes of animals the thread cells were developed within the ectodermal (or outer) coat of the animal. The type of structure also differed in the Protozoon, Hydro-medusa, and Annelid; and the thread cells discovered in Eolis resembled exactly those of the Hydro-medusæ in their structure. Mr. Alder, the greatest authority on these animals, still hesitates to assent to the doctrine, on account of its apparent extreme improbability.

Kelner's Orthoscopic Eyepiece.—Mr. Ross has brought out an eyepiece under the above name, said to possess over the Huyghenian eyepiece the advantages of a very much larger field, with more light, and yet without any sacrifice of defining quality. With a "Kelner" eyepiece you may magnify an Arachnodiscus until it appears equal to a dinner-plate in size, and yet be able to see the whole of the object.

MINERALOGY, METALLURGY, AND MINING.

MINERALOGY.

Petroleum.—Amidst the fears of the timid, the trade in this liquid mineral continues to increase with extraordinary rapidity. According to the circular of a Liverpool merchant, although the American oil was almost unknown in 1860, a total of 9,000,000 gallons was imported into Europe in 1862, and not one disaster happened in connection either with its transit or storage which would not equally have occurred to any other article of production. Recent advices from Belgium state that the Minister of the Interior has just taken occasion expressly to declare that this oil is not to be considered as one of the articles of inflammable merchandize which must be treated by special regulation as essentially dangerous. It is said that a line of steamers are to ply in the ensuing summer between New York and a British port, solely for the purpose of conveying it to Europe. A new well has recently been opened, which is said to yield 300 barrels per day; but the consumption of the article will be so great as to absorb all that can possibly be produced.

Odour of Precious Stones.—Fournet discovered that many precious stones owed their colours to carburets of hydrogen. In 1855 J. Schneider, by analysis, confirmed this discovery. In a note recently inserted in Poggendorff's *Annalen*, Schneider calls the attention of mineralogists to the empyreumatic odour which certain forms of quartz and granite give forth

when rubbed. He thereby perceives the indication of the presence of organic matter or carburet of hydrogen.

Triphyline, which is a triple phosphate of lithia, manganese, and iron, has until lately been known to exist in one locality only—at Bodenmais, in Bavaria. Mr. Geo. J. Bush has recently shown that it occurs along with Spodumene at Norwich, Massachusetts.

Carnelian is a variety of chalcedony (a form of quartz), generally of a clear bright red tint, from the presence of iron. At a recent meeting of the Manchester Philosophical Society, Mr. Joseph Sidebotham exhibited a carnelian pebble, with a cavity containing a globule of water, brought from the coast of Tuscany. These pebbles, it was said, are often picked up on the shore, and, when broken, exhibit a crystalline cavity about one-third filled with water.

Connellite is another extremely rare mineral, of great beauty, which has never had a satisfactory locality assigned to it. Professor Maskelyne has recently found specimens of it in a collection of undoubted Cornish minerals. The crystals of the mineral are very minute, and the Professor, in order to measure them, combined a small telescope and a small lens with the ordinary reflecting goniometer.

Lanthanite (*Carbonate of Lanthana*).—The determination of the crystalline form of this mineral is another example of the use of polarized light. It has been hitherto supposed that it crystallizes in the pyramidal system; but M. Descloizeaux found recently, in the course of his important researches on the optical properties of minerals, that lanthanite possesses two optic axes, and the crystals of lanthanite must therefore be considered to belong to the prismatic system.

Thallium.—This most recently discovered element appears to be widely diffused in certain classes of minerals. Mr. Crookes states that upon examining a large collection of cupriferous pyrites from different parts of the world he found it present in more than one-eighth; but he has very rarely met with it in pyrites in which copper is absent. On the other hand, M. Fred. Kuhlmann says that certain specimens of pyrites which furnish thallium in quantity came from near Spa, and consisted of sulphide of iron with veins of blende and galena. The pyrites was used for manufacturing sulphuric acid; and by causing the gases to go through a supplementary chamber, before passing to the leaden chambers, deposits were obtained very rich in the new metal, and also in arsenic and selenium. By this process the sulphurous acid, and consequently the sulphuric acid, were rendered much more pure. Mr. Crookes observes that he has no hesitation in saying that in some of our large copper, sulphur, and sulphuric acid works, thallium is at the present time being thrown away by the hundredweight, whilst it might easily be saved.

Native Copper.—The largest known supplies of native copper are those on the coast of Lake Superior. Two great masses have been recently discovered in the Mesnard district, Michigan, which have excited considerable attention as evidences of the inexhaustible and wonderfully productive nature of the Lake Superior region. Little of the first mass was above the surface when first discovered, and that little was so covered with moss and small underbrush as scarcely to attract attention. Upon

being uncovered traces of Indian workings were found. Two specimens were cut off, which were shown to be very compact pure copper. One of the masses found was forty feet in length by four in breadth, and weighed about fifty tons.

Native Silver.—No one would think of mining for silver in the stomach of a mule, yet in the Geological Museum there is a lump of silver "about as much as would make forty shillings," which has been taken from such a locality. It appears to be a common occurrence to find quantities of silver in the stomach and intestines of mules working in the Mexican silver mines, and its presence is accounted for by the mules eating mud, which contains much silver, for the purpose of obtaining the salt which is also mixed up with it. The silver is said to accumulate to a considerable extent without proving injurious.

METALLURGY.

The Dowlais Iron Works.—In our last number we stated that the weekly make of iron is 130 tons. It should have been added, that this is the produce of *each* of the eighteen furnaces possessed by that establishment. At present it appears to be about 150 tons per furnace, or about 2700 tons weekly for the whole establishment. In many districts the weekly make of iron per furnace varies from 250 to 300 tons.

Aluminium.—This metal has risen suddenly to a position of great importance. Although isolated by Sir Humphrey Davy, and obtained in globules by Wöhler in 1845, it was not prepared in any quantity, until within the last few years, when Deville's improvements led to its being produced in considerable masses. Messrs. Bell, of Newcastle-on-Tyne, now manufacture it largely by Deville's process, which essentially consists in the decomposition of dry chloride of aluminium by means of sodium. The metal was exhibited by this firm, and by Messrs. Morin & Co., of Nanterre (Seine), at the late International Exhibition, under the form of bars, wire, sheets, tubes, foil, castings, and forgings. It has been drawn into wire by M. Garepou, of Paris, and it is said to be from 60 to 100 per cent. cheaper than silver wire. It is exceedingly light (its specific gravity being little more than 2·5); thus, a sextant in brass will weigh 3 lb., which, if made of aluminium, weighs only 1 lb. 9 oz. Such a sextant, and also various other philosophical instruments of the same material, were exhibited by Messrs. Bell. They have recently produced a modification, which they term "whitened aluminium," in which the unpleasant zinc-like hue of the metal is obviated. They have also formed keys of aluminium, alloyed with 2 per cent of nickel, to increase its hardness. From aluminium wire and foil the lighter weights used for chemical purposes may be advantageously made, since, occupying something like seven times the space of those of platinum, they are more easily adjusted and handled, and less likely to be lost. MM. Collett, of Paris, have constructed a chemical balance, in which every part, down to the milled head by which the beam is released, is made of aluminium. It would appear, however, that this metal is destined to be more useful as a constituent of alloys, than in the unalloyed form.

Aluminium Bronze is a beautiful alloy of copper and aluminium. Various articles made of it were shown in the International Exhibition; they attracted much attention, especially some watch-cases made by Messrs. Reid, of Newcastle, which so closely resembled gold as not to be distinguished from it by experienced persons. Aluminium bronze is made of three qualities—the first containing 10, the second $7\frac{1}{2}$, and the third 5 per cent. of aluminium, the rest being copper. These varieties are scarcely to be distinguished from gold, except by their specific gravity, which is scarcely half that of the precious metal. They tarnish much less readily than any metal usually employed for astronomical instruments, viz., gun-metal, brass, silver, cast-iron, or steel. In making the alloy, extremely pure copper must be used. The best is that deposited by electricity, but that kind is very expensive; the next best is native copper from Lake Superior.

Fusion of Steel in large Masses.—M. Sudre has succeded in melting large quantities of steel in a reverberatory furnace, the steel being preserved from oxidation and from change of properties by a covering of slag, such as may be obtained from charcoal melting furnaces, or common bottle-glass.

The Spectroscope in Steel-Casting.—It is said that a practical application is likely to be made of spectrum analysis in the fusion of steel, by the examination of the gases evolved from the melted metal, which will enable the workmen to detect the point at which the required effect is produced, and so to arrest the operation at the right moment.

Properties of Steel.—Mr. David Kirkaldy has found that the same piece of wrought iron or steel, on being broken, may present a fibrous or a crystalline fracture according to the rapidity with which the fracture takes place; and hence there is no such change as is commonly supposed to take place in the metal, from a fibrous to a crystalline condition when subjected to vibration. He also found that steel is reduced in strength by being hardened in water, while the strength is vastly increased by being hardened in oil.

Mr. Charles Bathoe, states that in India glaziers never use a diamond to cut glass, but they do all their work with a hardened steel point. He has himself hardened steel so that it was as brittle as glass, by plunging it at nearly a white heat into iced water.

Captain Caron, Director of the French Imperial Laboratory, has experimented upon the formation of steel and the result of tempering. He regards the latter as in effect analogous to the blow of a hammer, but more potent, because acting in every direction at once. It causes a more intimate union between the carbon and the iron. The more suddenly the cooling takes place in the process of tempering, the stronger is the effect produced.

Applications of Steel.—At a late meeting of the South Wales Institute of Civil Engineers, Mr. Parry, of Ebbw Vale, stated that steel rails laid down on the Midland Railway nearly six years ago, over which trains have since passed 700 times daily, are to this hour uninjured. They were made by Mr. Mushet's process.

Steel-wire ropes are now extensively used in winding minerals from

mines, gradually displacing those of iron wire, which, to have the same strength, require to be very much thicker and therefore heavier than those of steel.

Sulphuretted Hydrogen in the Reduction of Copper.—It has been discovered that this gas may be prepared in large quantities, from the ignition of pyrites under certain conditions. The process is now adopted in Norway, and applied to the separation of copper from poor cupriferous pyrites.

Copper Ore in Cheshire.—At Alderley Edge, is a very singular deposit of copper ore which has impregnated sandstone. Although the percentage of copper in the sandstone is not more than 1¼, yet, by the methods of reduction practised, the copper is separated with profit on an extensive scale. The average yield of the mines is 25 tons of copper precipitate monthly; and the profits have reached to some thousands of pounds yearly. Mr. George Henwood, who lately inspected the works, describes the process adopted. It consists in grinding the stone, and then submitting it to the action of hydrochloric acid for eighteen or twenty-four hours, when all the copper will be extracted and the sand made perfectly white. The liquor is drained off, and scrap iron placed therein, which soon precipitates all the copper, the precipitate is washed and dried, and is then ready for the market.

MINING.

Mineral Statistics.—In the paper of Mr. Robert Hunt, already referred to, we find various statistics of the mineral products of the United Kingdom for 1861. They have also appeared in a separate form.

Number of collieries	3,052
Quantity of coal raised...	83,635,214 tons
Value	£20,908,803
Lives lost annually in coal mines ... about	1,000

In the ten years ending 1860 the number of lives lost was 9,090.

Total value of metals produced from British minerals in 1861...	£13,693,550
Coals	20,908,803
Total value of mineral produce	£34,602,353

Amongst the metals, gold appears for the first time to the extent of £10,816, being the production of the Merionethshire mines.

The value of the silver extracted from lead ore raised in the United Kingdom in 1861, was £144,161.

In Great Britain there are 336,000 persons actually engaged in mining operations, exclusive of those in quarries of all kinds. Of these 250,000 are coal miners. Probably not more than 300 of the whole number are receiving any such course of instruction as is necessary to fit them for the labours for which they are destined.

Boring by Diamonds.—Some time since it was suggested that black or rough diamonds might be employed for the perforation of hard rocks. This suggestion has been put into practice by a French engineer, M.

Leschol. The instrument he uses is made out of a tube furnished with a circular cutter of rough diamonds.*

Mining by Machinery.—Very little has yet been done to supersede manual labour in the excavation of mineral substances, but the matter is now beginning to receive attention. In metallic mines, Crease's excavating machinery is said to be highly successful. The inventor engages that such machines, fitted with two augers, shall work at the rate of 500 to 700 blows per minute, each auger independent of the other, and working at any angle whatever.

Attempts have been made at various times to arrange machinery for getting coals, but until very recently none has stood the test of experience. It will be necessary to explain that in getting a seam of coal, the first operation is usually that called "holing," or "undercutting," which consists in making a horizontal excavation into the coal at the base of the seam by means of the pick. It is in this process that the chief labour of coal-getting consists; and whoever has seen half-naked colliers engaged in this toil, kneeling, or perhaps lying on their side, must feel that it is very desirable to substitute machinery for such terrible work. Some years ago a coal-cutting machine was invented by Mr. Peace, of the Earl of Crawford's Collieries, Wigan, in which an endless chain, provided with teeth, was made to revolve; but it has long been disused. A machine has lately been invented, however, which is at present employed at the West Ardsley Colliery, near Leeds, and which bids fair to be very successful. It may be briefly described as a collier's pick in the hands of a machine. The pick is made to act in any direction; but for holing it will, of course, strike horizontally. The handle of the pick forms the long arm of a "bell-crank," of which the shorter arm (which moves through a much smaller space) is actuated by the piston of a cylinder. To work the latter, compressed air is forced in pipes down the pit to the cylinder, and moves the piston just as steam would do, but with the advantage that the escape air assists in the ventilation of the working place. The whole machine is mounted on wheels, and can be run on tramways from place to place.

PHOTOGRAPHY.

THE adjudicators appointed by the Council of the Photographic Society have awarded the prize medals for the best contributions in six distinct branches of photographic art, as follows:—

M. Claudet, for the best portraits.

Mr. Francis Bedford, for the best landscapes.

Colonel the Honourable Stuart Wortley, for the best instantaneous pictures.

Viscountess Hawarden, for the best amateur contribution.

Mr. H. P. Robinson, for the best composition picture from life.

Mr. Thurston Thompson, for the best reproduction.

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* A description of it will be found in our Continental Summary.

It is to be hoped that the rewards offered this year for the first time may serve as a stimulus to increased exertion on the part of the contributors to future exhibitions of the Photographic Society.

His Majesty the Emperor of the French has bestowed the cross of the Legion of Honour upon three photographers whose productions were most deserving of attention in the late International Exhibition; viz., M. Bayard, for useful photographic inventions; M. Duboscq, for improvements in optical instruments; and on M. Poitevin, for his inventions in carbon printing and photo-lithography.

The premium of 2,000 francs offered, in the year 1856, by the Duc de Luynes, for the best method of printing in carbon, has ultimately been divided into four minor prizes, and bestowed as follows:—A gold medal of the value of 600 francs was given to M. Poitevin, as the originator of the first idea upon which the carbon printing processes were based; viz., the peculiar action of light upon a combination of organic matter with salts of chromium. The merit of this invention appears, however, to rest with Mr. Mongo Ponton, who as far back as May, 1839, communicated to the Royal Scottish Academy of Arts his discovery of the action of sunlight upon paper steeped in a solution of the bichromate of potash. The second gold medal, of equal value, was bestowed upon MM. Davanne and Girard for their researches into the causes of the fading of silver prints. A silver medal valued at 400 francs was awarded to Messrs. Garnier and Salmon, for their process of printing in carbon; and a similar medal was given to Mr. Pouncey, of Dorchester, for his invention of the same character. Subsequently the reward conferred upon M. Poitevin has been augmented by 2,000 francs, and an additional medal presented to M. Fargier for his process.

The practical photographer is indebted to M. Meynier for two valuable suggestions. The first refers to the use of the double sulphate of iron and ammonia as a developing agent. The aqueous solution of this salt possesses the advantage of greater permanence, whilst as a reducing agent it is eqally efficient with the simple sulphate. Several distinguished operators have pronounced very favourably upon the capabilities of this salt as readily giving exquisite half-tone with a proper amount of intensity in the high lights. It is manifestly requisite to employ such a larger proportion of this salt as will compensate for the diminished amount of actual protoxide of iron in the compound; a solution containing 25 grains of the double sulphate, with 25 minims of acetic acid to the ounce of water, is stated by Mr. G. Wharton Simpson to give excellent results. The second suggestion, offered by M. Meynier, has reference to the employment of the sulpho-cyanide of ammonium as a fixing agent, both for negatives on glass and prints upon paper. This compound has the property of dissolving both the iodide and chloride of silver, forming solutions which are not liable to the deposition of the black sulphide on heating or standing at rest for some time. The proposition has been made the subject of experiment, and reported upon by Mr. Spiller, who states that this re-agent is the only one known to have the power of removing the whole of the silver from the preserved white portions of albumenized prints, and that the cost of this

article constitutes its only disadvantage. MM. Davanne and Girard have more recently confirmed the favourable opinion expressed by Mr. Spiller.

A very ingeniously-constructed microscopic camera has recently been introduced by Mr. A. F. Eden, of Crown-court, Threadneedle-street. It is made to serve a variety of purposes, and can be used either for taking reduced copies of photographic pictures or direct miniature portraits from nature, to be examined afterwards by the aid of an ordinary microscope; or may be employed inversely for the production of magnified representations of microscopic objects. The instrument may be described as consisting of a photographic camera adapted to the body or tube of an ordinary microscope; and, although the combination serves the purposes already enumerated, the two portions may be disconnected, and each used separately. Thus, to the mahogany camera may be adapted a landscape lens of about sixteen inches focus, when it becomes suitable for copying and for taking small views on plates of sizes up to seven inches square; likewise the optical portion of the instrument may be mounted on a brass stand, and requires merely an eye-piece to constitute an effective compound microscope. The manner of using the instrument may be briefly described. Supposing it be required for taking a micro-photograph, or reduction from an ordinary negative, the latter is supported in the position usually occupied by the ground-glass, or dark side in a camera of the usual construction. This end of the instrument is provided with a large plane reflector attached by a hinge, and capable of adjustment to any angle which may be required to direct the rays of the sun or diffused daylight through the negative and axis of the camera. By means of the microscope object-glass in front of the camera, a sharply-defined image is depicted upon the screen of a little dark box placed a short distance beyond. The lens may be adjusted and focussed by the aid of a rackwork and pinion movement; and when the optical perfection of the image is deemed satisfactory, the scratched glass is exchanged for the sensitized plate, in this instance represented by a single drop of collodion upon a slide of standard dimensions—one by three inches. The exposure will not usually exceed ten seconds in bright daylight, and the development occupies but a single moment, since it is advisable to guard against too great intensity in the minute photographic reproduction, in order that the speck of reduced silver on the glass may exhibit under assisted vision its proper gradation of light and shade. The beauty of the result, and the rapidity with which the whole process is executed, will possess a charm for those whose leisure moments are scarce, and whose laboratory facilities are of a limited character. On the other hand, by placing in the little dark box a microscopic object mounted on a glass slide, and removing the cap or stopper which prevents the access of daylight, an enlarged and well-defined image will appear upon the ground glass at the larger end of the camera. Having focussed in the same manner as before, this image now presents itself ready to be photographed, on merely holding the camera properly to the sun, or reflecting its rays from the small concave mirror placed at this extremity of the instrument. And further, by removing altogether the larger mirror the apparatus will be suitable for taking miniature portraits of sizes varying from that of a grain of mustard

seed to such as would be mounted in a small locket. The one-inch lens is that preferred for general use, but a lower power is also provided. Both of these object-glasses have their photographic and optical foci coincident; no allowance need therefore be made in the adjustment of the sensitive plate; and the fact that Mr. Eden was for some years a pupil of Mr. Andrew Pritchard is so far a guarantee for the perfection of the optical part of the microscopic camera.

PHYSICS.

PROFESSOR W. A. MILLER, of King's College, London, has published in the Proceedings of the Royal Society an abstract of an important investigation "On the Photographic Transparency of various Bodies, and on the Effects of Metallic and other Spectra obtained by means of the Electric Spark." The first portion of his paper refers to the absorbent action of various media upon the *chemical* rays of the electric spark, the spark or light being obtained between two metallic wires (generally of fine silver) connected with the ends of the secondary wire of a strong induction coil. The light was first passed through a narrow vertical slit in a piece of metal, then through the substance to be examined, which, if a liquid, was contained between two thin plates of polished rock-crystal, then through a quartz prism placed at a suitable distance, immediately upon this, through a lens of rock-crystal; and at a suitable distance the spectrum was received upon a sensitive collodion surface in a camera. His experiments with *gaseous* substances were made by interposing in the track of the ray, between the vertical slit and quartz prism, a brass tube, two feet long, closed at each end, air-tight by means of a plate of quartz, and each gas or vapour was introduced separately into the tube.

His general results were:—1st. That colourless bodies which are equally transparent to the visible rays vary greatly in permeability to the chemical rays; 2nd. Bodies which are photographically transparent in the solid state preserve their transparency in the liquid and gaseous states; and 3rd. Colourless transparent solids which exert a considerable photographic absorption, generally preserve that power when converted into liquids or gases, and it makes no difference whether they are liquefied by means of heat or by being dissolved in water. He employs the term "diactinic" to express the power which bodies possess of transmitting the actinic or chemical rays.

The experiments upon gaseous bodies gave important results, showing, however, but little coincidence with those of Tyndall on the absorbent power of gases for radiant heat. Amongst the colourless gases, atmospheric air, oxygen, hydrogen, nitrogen, carbonic oxide, and carbonic acid, exert no absorbent power; olefiant gas, nitrous oxide, cyanogen, and hydrochloric acid slightly absorb the chemical rays; whilst with coal gas the more refrangible half of the chemical spectrum was entirely cut off. Then follow, with increasing power, sulphurous acid, bisulphide of carbon, and terchloride of phosphorus. Atmospheric air saturated with

vapour of benzol absorbs the chemical rays more powerfully than coal gas, but if the vapour of ether, chloroform, or oil of turpentine, was substituted for that of benzol, the effect was much less marked.

Of eighteen different liquids water was found to be the most freely diactinic, and though eminently transparent to the chemical rays, it is less so than atmospheric air and certain other gases. Absolute alcohol is next, but exhibits a considerable falling off. Then follow Dutch liquid, chloroform, ether, benzol, glycerine, fousel oil, wood spirit, oxalic ether, acetic acid, oil of turpentine, glycol, carbolic acid, liquid paraffin, and bisulphide of carbon ; whilst terchloride of phosphorus and oxychloride of phosphorus, although perfectly limpid and colourless to light, absorb all the chemical rays. Saturated solutions of potash, soda, phosphoric acid, and arsenic acid, exert considerable absorbing power.

Of solids, the most perfectly diactinic are rock-crystal, ice, and white fluor spar, though less so than atmospheric air and certain other gases. Rock-salt is nearly equally transparent. Then follow the sulphates of baryta, lime, and magnesia, and those of the alkalies. The carbonates, borates, phosphates, and arseniates, of the alkalies and alkaline earths, are also tolerably transparent. Although the sulphates are generally freely transparent, the sulphites are much less so, and the hyposulphites absorb about three-fourths of the length of the spectrum, leaving only the less refrangible portion. The chlorides and bromides of the alkalies and alkaline earths, and soluble fluorides, are freely diactinic, but the iodides are much less so. Amongst the salts of inorganic acids the nitrates are the most powerful in absorbing the chemical rays, a solution of either of them absorbs all the more refrangible rays and reduces the chemical spectrum to less than one-sixth of its ordinary length. The chlorates have a much less powerful absorbing action. Organic acids and their salts strongly absorb the more refrangible rays in the following order : citrates, acetates, tartrates, and oxalates, the latter being the strongest. The different varieties of sugar are freely transparent.

The second portion of Dr. Miller's paper treats of the Electric Spectra of the Metals. All the ordinary, and many rare metals were employed, and in all the experiments the image of the spectrum was received and fixed upon a photographic surface. In many cases, metals which are allied in chemical properties exhibit a certain similarity in their spectra ; for instance, iron, cobalt, and nickel ; also bismuth, antimony, and arsenic. Volatile metals generally give the strongest lines. Some of the experiments were made with the metallic electrodes immersed in various gases, and it was observed that certain gases, such as hydrochloric acid, sulphurous acid, and nitrous oxide, greatly resisted the passage of the electric sparks.

A valuable paper on the stratified appearance in Electrical Discharges, by J. P. Gassiot, F.R.S., has been printed in Number 53 of the Proceedings of the Royal Society. He describes numerous experiments with a battery consisting of 3,360 pairs of plates, acting upon various rarified gases, in glass tubes ; and especially examines "the effects obtained by varying the resistance." He states that the stratified discharge from a *single* disruption of the primary wire of an induction coil, is identical in

character with the continuous discharge of a voltaic battery. The form and positions of the striæ appear to depend upon the power of the battery, and upon the state of tension of the rarefied gases. The number of striæ appears to indicate the degree of tension in a closed battery circuit, as a gold-leaf electroscope does in an unclosed circuit, and can be regulated by introducing different amounts of resistance into the circuit. The number of striæ decreased as the amount of resistance introduced into the circuit was increased; but at the same time the striæ assumed a different shape, and the bright and dark portions at the tube occupied different positions.

Reitlinger has put forward a new explanation of stratified electric light, as seen in rarefied media. He supposes that in a tube filled with rarefied aqueous vapour, the hydrogen and oxygen are disposed in alternate layers, and that the oxygen being a worse conductor of electricity than hydrogen, becomes much more heated, and thereby much more luminous, and thus produces dark and bright bands. In support of this view, he states—1st, that no stratification has been produced by elementary and unmixed gas; and 2nd, that the vapour of mercury alone gives only a white light, without stratification, but immediately on adding a few bubbles of air to it, dark bands appear.

An abstract of a paper, "On the Long Spectrum of Electric Light," read before the Royal Society, by Professor G. G. Stokes, F.R.S., has been published in the Proceedings of the Royal Society. He employed as the source of light the spark of an induction coil, with a Leyden jar connected with the secondary terminals; and examined the light evolved by electrodes of different metals. He found light from aluminium electrodes the richest in invisible rays of extreme refrangibility, and therefore used that metal when examining the behavour of those particular rays. This portion of the spectra of the metals may be viewed by means of fluorescence, and its mode of absorption by different liquids also observed by the same means. He finds that solutions of alkaloids and glucosides are usually very opaque to those rays, and some of them produce bands of maximum opacity in particular parts, highly distinctive of the special substance under examination. In natural crystals of adullaria and felspar, generally a strong fluorescence is produced by these invisible and highly refrangible rays. A particular variety of fluor-spar shows a decided reddish fluorescence under the exclusive influence of rays of the very greatest refrangibility, and will therefore form a valuable means of detecting those rays.

In the "American Journal of Science and Arts," January, 1863, is a paper, "On the Equivalent and Spectrum of Cæsium," by S. W. Johnson and O. D. Allen. It professes to contain a more extended description of the lines composing the cæsium spectrum than that given by Kirchoff and Bunsen, and states that it is the most beautiful of all the spectra of the alkali and earth metals.

M. Janssen has described in the Comptes Rendus some new spectroscopes: the first is one with direct vision, it unites great dispersive power with simplicity of construction, and seems well adapted for optico-chemical analysis; the second is a pocket instrument, forming a small folding glass, and is also adapted for direct vision, by means of it the solar spectrum can

be seen in the feeblest and most diffused light; but it is more specially adapted for the analysis of flames. A new form of spectroscope has also been described by Dr. Wolcott Gibbs, in the "American Journal of Science," vol. xxxv., page 110.

An abstract of a paper, "On the Reflection of Light from Polished Surfaces," by Rev. S. Haughton, F.R.S., has appeared in the "Proceedings of the Royal Society." The following are some of the conclusions arrived at. That silver is the only substance which possesses the qualities of *brilliancy* and *lustre*. Of the metals which have high *brilliancy* and little *lustre* may be named mercury, palladium, zinc, and iron. Of those which have high *lustre* and little *brilliancy* there are only two, gold and copper.

A paper, entitled "Some Remarks upon Light," has been read by Mr. B. S. Proctor before the Microscopical Society of Newcastle-upon-Tyne. The author shows that substances usually considered opaque, such as ordinary white lead, &c., are not so; but that, as a rule, in white powders, pretty free transmission of light takes place through the individual particles. He examines the question, why some substances, such as white lead, when mixed with oil, possess a greater "body," or opacity, than other substances, such as magnesia, which appear equally opaque in the dry state; and shows that, in the latter case, it is because the refractive power of the substance is nearly allied in degree to that of the oil, whilst in the former case it is very different, and with white lead much higher than that of the oil. The opacity of bodies was also further examined, and it was shown that no definite line could be drawn between transparent and opaque bodies, all were transparent in some slight degree when reduced to a very thin film; and each then showed its own peculiar colour: thus gold and copper appeared green, silver violet or purple, arsenic brown, iodine red-brown, antimony and charcoal grey, &c.

Mr. H. Treppass has exhibited at the Royal Institution a new optical instrument, called a charimorphoscope. It contains improvements upon the kaleidoscope of Sir David Brewster, the effects being under the control of the operator, who is thus able to produce in relief, delicate or simple, gorgeous and elaborate patterns, according to his own fancy.

Dr. Tyndall, in a paper "On the Absorption and Radiation of Heat by Gaseous Matter," in the "Philosophical Magazine," describes what he terms "dynamic radiation and absorption," or the radiation and absorption of heat by gases and vapours without any source of heat external to the gaseous body itself. The method he adopts is to admit a minute portion of the gas to be examined into the exhausted tube of his apparatus for determining the degree of transparency of gases for heat, and then allow dry air to enter the tube and mix with it; the gaseous mixture thus increasing in density becomes slightly heated. In the case of boracic ether he found that the radiation of an amount of vapour possessing a tension of less than a thousand-millionth of an atmosphere was perfectly measurable. The absorbent action of perfumes and essential oils for heat was also examined; and, in the instances of spikenard and aniseed, it was found to be upwards of 350 times that of dry air. He further examined the thermic absorption of electrolytic oxygen, *i.e.*, ordinary oxygen containing ozone, and found that, in proportion as the size of the electrodes

which evolve the oxygen was diminished, the proportion of ozone in the gas increased, and its thermic absorption also increased, until it amounted to 136 times that of ordinary oxygen; but even in this experiment the quantity of ozone operated with was perfectly unmeasurable by ordinary means. He considers, for the present, that ozone is produced by a packing of the atoms of ordinary oxygen into oscillating groups, and that heating dissolves the bond of union, and allows the atoms to swing singly, and thus converts ozone into ordinary oxygen.

A paper was also recently read by the same author at the Royal Institution, "On Radiation through the Earth's Atmosphere." In a former communication he showed that the aqueous vapour in the air absorbed a vastly greater proportion of heat than did the air itself, although the aqueous vapour was only in the proportion of 1 to 199 parts of the other ingredients of the atmosphere. Several objections had been made to this result, and he now discussed those objections, and showed, in various ways, that watery vapour is opaque in an extraordinarily great degree to such rays of obscure heat as are emitted by the earth after it has been warmed by the sun, and that more than ten per cent. of the terrestrial radiation of heat from the soil of England is stopped within ten feet of the surface of the soil. The contents of this paper are similar to that of one by the same author recently read before the Royal Society, the object of which was to prove to meteorologists that they may apply, without misgiving, the results which the author had previously announced, regarding the relation of aqueous vapour to radiant heat.

M. Dufour, in the "Comptes Rendus," describes some new experiments upon the degree of rapidity of combustion of fuses under different pressures of the atmosphere. His experiments were made in the open air, and the difference of pressure was obtained by igniting them at different elevations on the Alps. His results confirm those of Quartermaster Mitchell and Professor Frankland, each of whom found that the rapidity of combustion increased with the increase of pressure.

Mr. T. H. Hill has presented to the Royal Institution some specimens of woods which had been charred by exposure to a temperature not exceeding 250° Fahrenheit, the heat being generated by steam pressure of about 10 or 12 pounds per square inch.

ZOOLOGY.

The Controversy concerning the Brains of Man and the Apes.—This has assumed a somewhat new aspect, from the appearance of an account of it given by Sir Charles Lyell, in his recent work on the "Antiquity of Man," where he states that in 1862 Professor Owen (in his paper before the British Association), "without alluding to the disclaimer of the Dutch Anatomists of their defective plates, observes that in the gorilla *the cerebrum extends over the cerebellum, not beyond it;* correcting the description of the same brain given by Professor Owen in 1861, 'in which a considerable part of the cerebellum of the gorilla is represented as uncovered.'" Professor Owen takes exception to this statement of the case, as leading to the

inference that, in regard to the same brain, he represented it as showing one structure in 1861, and another in 1862; and in a lengthy letter addressed to the *Athenæum* he endeavours to explain the circumstances. Sir Charles Lyell, in reply, expressing every desire to retract any exaggerated statement which he may have made, admits only one unimportant error, and, quoting from the published reports of Professor Owen's papers, confirms his original statements. These letters have also called forth others from Professor Rolleston of Oxford, and Mr. Flower of the Royal College of Surgeons. The former takes exception to three points referred to in Professor Owen's letter, and the latter is adduced by Sir Charles Lyell as a witness on his own behalf, to prove that the representation of the brain of a chimpanzee put before the public by Professor Owen in support of his views was an inaccurate one, in which the hemispheres had so glided apart that one was actually a quarter of an inch longer than the other, and that the figure was thus distorted, and the two dimensions of each hemisphere were not given.

The Ape-Origin of Man. — The supporters of this doctrine will be delighted with the conclusions enunciated by Professor Huxley, in his work just published on "Man's Place in Nature," who says that the sagacious foresight of the great lawgiver of systematic zoology, Linnæus, becomes justified, and a century of anatomical research brings us back to his conclusion that man is a member of the same order (for which the Linnæan term *Primates* ought to be retained) as the apes and lemurs. Professor Huxley, however, admits a chasm between man and the ape, which it would be no less wrong than absurd to deny; but it is at least equally wrong and absurd to exaggerate its magnitude. Although, however, the anatomical test is of such a character that Wagner, in his paper on the structure of the brain in man and monkeys (in the Archiv. fur Naturgeschichte, 1861), did not meet the objections of Huxley; though always remarking that Man is distinct from the Quadrumana, the objections brought forward by Huxley tend rather against the separation of Man in the special division assigned to him (viz., Archencephala) than against the separation itself.

Population of the Globe.—The *Abeille Medicale* gives some curious statistics upon this point from the most recent calculations. The earth is inhabited by 1,288 millions of inhabitants—viz., 369 millions of Caucasians, 552 millions of Mongolians, 190 millions of Ethiopians, 1 million of American Indians, and 200 millions of Malays. All these speak 3,064 languages, and profess 1,000 different forms of religion. The number of deaths per annum is 333,333,333, or 91,954 per diem, 3,730 per hour, 60 per minute, or *one per second;* so that at every pulsation of our heart a human being dies. This loss is compensated by an equal number of births. The average duration of human life throughout the globe is thirty-three years, but one-fourth of the population dies before the seventh year, and one-half before the seventeenth; but of 10,000 persons, only one reaches the hundredth year, while one in 500 attains the eightieth, and one in 100 the sixty-fifth.

Psychical Distinction of the Races of Man.—Mr. R. Dunn read a paper before the Ethnological Society upon this subject, maintaining that the

genus *Homo* was one and distinct, and that the study of the cerebral organization and development of the various typical races was one of the most effectual means of better understanding and elucidating the psychological differences which characterize them. The Sandwich Islanders have excellent memories, and learn by rote with wonderful rapidity, but will not exercise the thinking faculties. It was found practically that negro children could not be educated with white children. In these cases the cognate faculties have not reached a complexity equal to the complexity of the relations to be perceived; and moreover this is not only so with the purely intellectual cognitions, but it is the same with the *moral* cognitions. In the Australian language there are no words answering to "justice," "sin," "guilt." Amongst many of the lower races of man, acts of generosity or mercy are utterly incomprehensible—facts which the author thought were in accordance with what might have been anticipated from the organic differences of the higher psychical activities.

Anthropological Society.—From the above paragraphs it will be seen that the science of *Man* is one at the present time much studied, and a new society under the above title has just been formed, with Dr. James Hunt as president, and Mr. C. Carter Blake as secretary. The society meets at 4, St. Martin's-place, on alternate Tuesday evenings.

The Unicorn of the Ancients.—Dr. Brehm, the African traveller, speaks thus of the unicorn: "Also in the interior of Africa, where I have travelled, the 'unicorn' (*Anasa* of the natives) is nothing more than the rhinoceros." The Rev. W. Houghton, in the "Annals of Natural History" for December, quoted Ctesias as describing unicorns under the name of *wild asses*, of whose horns drinking cups were made, of such virtue that those who drank from them were said to be subject to neither spasm nor epilepsy, nor to the effects of poison. Dr. Brehm remarks that, at the present day, in the interior of Africa, for example, at Carthum (Khartoum) drinking vessels and cups are still made from the horn of the rhinoceros, to which they attribute the very same properties as Ctesias did.

Preservation of Birds.—While the English farmer is energetically destroying small birds on his farm, the New Zealand farmer is making great efforts to obain a supply of such birds on his, for the purpose of destroying the insects which ravage his crops. The Acclimatisation Society of New Zealand are doing all in their power to promote the introduction into the colony of English field birds. The undermentioned amounts will be paid by the Society upon the delivery in Auckland, in a healthy condition, of a cock and hen of the following birds:—Blackcock (or grouse), cock and hen, 10 guineas; silver pheasants, ditto, £5; nightingales, £5; English partridges, £4; cuckoos, £3; missel thrushes, £2; common thrushes, £2; blackbirds, £2; starlings, £2; skylarks, £2; rooks, £2; crows, £2; jays, £1. 10s.; robins, 30s.; wrens, 30s.; bullfinches, £1; grey linnets, 15s.; green linnets, 15s.; sparrows, 15s.; goldfinches, 15s.; English quails, £1.

Walking Fish.—An observer in Province Wellesley, passing along during a shower of rain over the wide sandy plain which bounds the sea in the neighbourhood of Panaga, witnessed an overland migration of a fish much resembling the tench, called Ikan Puya, from a chain of

fresh-water lagoons lying immediately within the sea beach, towards the second chain of lagoons about a hundred yards distant inland. The fish were in groups of from three to seven, and were pursuing their way in a direct line towards a second chain of lagoons at the rate of nearly a mile an hour. When disturbed, they turned round, and endeavoured to make their way back to the lagoon they had left, but were caught by the Malay accompanying the observer. Upwards of twenty were taken during a walk of about half a mile. The ground these fish were traversing was nearly level, and only scantily clothed with grass and creeping salsolaceous plants, which offered very slight obstruction to their progress.

Immense Shoals of Flounders.—Illustrating the proverbial teeming life in the sea, a person writing from Göthenburg states that "there have been caught after the late storms on the coast of Denmark a quantity of flounders, estimated at two millions and a half in number, and they say the sea is literally full of them. They do not know what to do with any more they may take, though there is a salting establishment in full work already. Five hundred men were employed night and day for three weeks in catching these fish."

New Silk Moth.—The *Revue de Zoologie* says that the Minister of Agriculture in France has received from Japan living eggs of the oak silkworm, or *Bombyx Yama-Mai*, which it is hoped may be cultivated in the Jardin d'Acclimatation. Up to this time no European had been able to obtain this precious silkworm, all attempts having been hitherto met with a flat refusal, on the ground that the exportation of them was forbidden on pain of death. Young oaks in the South of France, Italy, and Algeria are in process of being forced in order to afford food to the precious insects, which it is expected will soon be excluded from the eggs.

Acclimatation of Sponges.—M. L'Amiral, who has been to the coast of Syria with a view to obtain sponges for transplantation, has returned, and presented a detailed report to the Société d'Acclimatation. He distinguishes three kinds of sponge for which there is a demand,—a fine soft sponge, a fine hard kind, and the common sort. These sponges are found in the Levant, between Alexandretta and Saida. When first gathered at the bottom of the sea, the sponge is covered with a black but transparent gelatinous substance, resembling vegetable granulations, among which microscopic white and oviform bodies may be distinguished, which are the larvæ. When arrived at maturity they are washed out by the sea water which incessantly flows through the sponge, and then swim along by the aid of cilia, until they attach themselves upon some rock and commence a new life. This emigration of larvæ occurs about the end of June and beginning of July. The fine qualities of sponge are chiefly found at a depth of fifteen fathoms, and the common sponges lie between twenty and thirty fathoms. At Tripoli (in Syria), divers were engaged and collected sponges, which were placed in boxes, through which a stream of sea water was made constantly to flow. These arrived at Marseilles on June 17th and thence they were taken to Toulon and the islands of Hyères, where stone troughs, with five sponges in each, were sunk in different places. The success of the experiment will not, of course, be known till next season.